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Determination of the Secular Perturbations of Minor Planet Ceres, arising from the actions of the eight Major Planets of the Solar System. By C. J. Merfield.

Introduction.—So far as the writer knows, there has been no complete determination of the secular perturbations of the minor planet Ceres.

Dr. Hill has published * a method of computing absolute perturbations, and as an example of the method he calculated † the secular perturbations of this asteroid in the cases of three of the major planets, Mars, Jupiter, and Saturn, the osculating elements by Schubert being adopted as a foundation of his work.

A system of Mean Elements of Ceres being now available, the writer was induced to undertake the complete determination of the secular perturbations of this body, as a contribution to the science of astronomy that seemed worthy of undertaking.

Elements.—The elements of the major planets, adopted in this work, are those given by Dr. Hill in his investigation ‡ of "A New Theory of Jupiter and Saturn." The Mean Elements of Ceres are by the same investigator, and are probably not very far from the true ones; no doubt, upon the whole, they will require very slight amendment, and the alterations necessary to bring about a better representation of the normal places will not influence the results to an extent requiring consideration.

* *Astronomische Nachrichten*, 1982.

† *Astronomical Journal*, 368.

‡ *Astronomical Papers, prepared for the use of the American Ephemeris and Nautical Almanac*, vol. iv. The masses of Venus, Earth, and Uranus adopted by Hill are 1/408134, 1/327000, 1/22640.

The values of the secular perturbations of Ceres, deduced from this inquiry, may be accepted as definitive if the preceding premise be found correct.

Methods of Calculation.—The method * of Gauss has been adopted, as explained by Dr. Hill. The values of the integrals, involved in the formulæ, have been interpolated from the table appended to his memoir. As the moduli in all cases came within the limits of the arguments given, this table was of much value, and considerably reduced the numerical work.

The values of the functions were deduced by the aid of seven figure logarithms; and, where it was advantageous, addition and subtraction logarithms, to a similar degree of accuracy, were used.

As the work proceeded, certain well-known checks were applied, and in all instances they were completely satisfied. The accuracy of the perturbations in the plane of the orbit has been verified by the usual formula; the residual is given in each case as an indication of the exactness of the calculation.

The equality of the summations of the functions for the odd and even divisions forms a useful control against large numerical errors, but it is not infallible, owing to certain circumstances arising in each special case.

Consulting the volumes, *locis citatis*, the significance of the notation will be found. The results of the determination are therefore given without further comment. Just so much of the numerical details are appended as will form a guide to a future investigation, and the detection of any errors that may have been made.

Elements of Ceres.

The following are the Mean Elements determined by Dr. Hill, and used as the basis of the investigation here presented.

Elements.

$$n = 281504''.850309$$

$$\text{Log } e = 8.89458493$$

$$\left.\begin{aligned} \pi &= 148^\circ\ 28'\ 32''.5 \\ \Omega &= \ 80\ 48\ \ 5.6 \\ i &= \ 10\ 37\ \ 6.2 \end{aligned}\right\} 1850$$

$$\text{Log } a = 0.4420738$$

Dividing the orbit into sixteen equal parts, with respect to the eccentric anomaly, the following values of the true anomalies and logarithms of the radii vectores are deduced.

* *Gauss's Method of Computing Secular Perturbations: Astronomical Papers, prepared for the use of the American Ephemeris*, vol. i. part v.

n	E	v	Log r	n	E	v	Log r
1	0°·0	0° 0′ 0″·00	0·4065934	9	180°·0	180° 0′ 0″·00	0·4748732
2	22·5	24 17 14·89	0·4093985	10	202·5	200 50 15·83	0·4724618
3	45·0	48 16 23·69	0·4172889	11	225·0	221 54 12·95	0·4655203
4	67·5	71 43 14·16	0·4288362	12	247·5	243 24 15·50	0·4549198
5	90·0	94 29 57·82	0·4420738	13	270·0	265 30 2·18	0·4420738
6	112·5	116 35 44·50	0·4549198	14	292·5	288 16 45·84	0·4288362
7	135·0	138 5 47·05	0·4655203	15	315·0	311 43 36·31	0·4172889
8	157·5	159 9 44·17	0·4724618	16	337·5	335 42 45·11	0·4093985

We also have the constant quantities used throughout the calculation—

$$\omega = 67^\circ\ 40'\ 26''\cdot90$$

$$\phi = 4\ 29\ 57\cdot82$$

$$\text{Log sin } \phi = 8\cdot8945849 \qquad \text{Log sin } i = 9\cdot2654471$$

$$\text{,, cos } \phi = 9\cdot9986595 \qquad \text{,, cos } i = 9\cdot9924988$$

$$\text{Log sin}^2\frac{\phi}{2} = 7\cdot1877800 \qquad \text{Log sin}^2\frac{i}{2} = 7\cdot9325686$$

I. Mercury.

Elements.

$$n' = 5381016''\cdot260$$

$$\text{Log } e' = 9\cdot31303314$$

$$\left.\begin{aligned} \pi' &= 75^\circ\ 7'\ 13''\cdot62 \\ \Omega' &= 46\ 33\ 8\cdot63 \\ i' &= 7\ 0\ 7\cdot71 \end{aligned}\right\} 1850$$

$$\text{Log } a' = 9\cdot5878217$$

$$m' = 1/7500000$$

$$\text{I} = 6^\circ\ 13'\ 11''\cdot06 \qquad \text{K} = 72^\circ\ 49'\ 16''\cdot31$$

$$\Pi = 208\ 23\ 0\cdot32 \qquad \text{K}' = 73\ 9\ 33\cdot89$$

$$\Pi' = 135\ 23\ 35\cdot24$$

$$\text{Log } k = 9\cdot9987395$$

$$\text{Log C} = 7\cdot8017097 \qquad \text{,, } k' = 9\cdot9987043$$

Secular Perturbations.

$$\left[\frac{de}{dt}\right]_{00} = -0''.000020 \qquad \left[\frac{d\Omega}{dt}\right]_{00} = -0''.000257$$

$$\left[\frac{d\chi}{dt}\right]_{00} = +0''.000521 \qquad \left[\frac{d\pi}{dt}\right]_{00} = +0''.000517$$

$$\left[\frac{di}{dt}\right]_{00} = +0''.000047 \qquad \left[\frac{dL}{dt}\right]_{00} = +0''.076247$$

$$A_1^{(s)} \sin\phi + B_0^{(c)} \cos\phi = -0.0000000013$$

II. Venus.

Elements.

$$n' = 210664''.357$$

$$\text{Log } e' = 7.8352533$$

$$\left.\begin{aligned} \pi' &= 129^\circ\ 27'\ 42''.83 \\ \Omega' &= 75\ 19\ 53.08 \\ i' &= 3\ 23\ 35.01 \end{aligned}\right\} 1850$$

$$\text{Log } a' = 9.8593378$$

$$m' = 1/425000$$

$$I = 7^\circ\ 14'\ 52''.52 \qquad K = 19^\circ\ 12'\ 48''.63$$

$$\Pi = 245\ 6\ 39.72 \qquad K' = 18\ 45\ 15.08$$

$$\Pi' = 226\ 7\ 37.99$$

$$\text{Log } C = 5.3891827 \qquad \text{Log } k = 9.9981963$$

$$,, \quad k' = 9.9983334$$

Secular Perturbations.

$$\left[\frac{de}{dt}\right]_{00} = -0''.000025 \qquad \left[\frac{d\Omega}{dt}\right]_{00} = -0''.026580$$

$$\left[\frac{d\chi}{dt}\right]_{00} = +0''.037022 \qquad \left[\frac{d\pi}{dt}\right]_{00} = +0''.036567$$

$$\left[\frac{di}{dt}\right]_{00} = +0''.000219 \qquad \left[\frac{dL}{dt}\right]_{00} = +1''.395618$$

$$A_1^{(s)} \sin\phi + B_0^{(c)} \cos\phi = +0.0000000004$$

Owing to certain circumstances, a verification of certain functions was undertaken. The orbit of Ceres was again divided into another sixteen parts, and the result of the investigation fully established the correctness of the previous calculation. The summations of the various functions, denoted by Σ_3, are given below the tabular statement, for comparison with $\Sigma_1 + \Sigma_2$. The check on the perturbations in the plane of the orbit in this instance gives a residual—

$$-0''.000000004$$

The above results are deduced from the several functions of the first investigation.

III. Earth.

Elements.

$$n' = 1295977''.416$$

$$\text{Log } e' = 8.22456263$$

$$\left.\begin{aligned} \pi' &= 100^\circ\ 21'\ 39''.73 \\ \Omega' &= \text{—}\ \text{—}\ \text{—} \\ i' &= 0\ \ 0\ \ 0''.00 \end{aligned}\right\} 1850$$

$$\text{Log } a' = 0.0000000$$

$$m' = 1/322800$$

$$I = 10^\circ\ 37'\ 6''.20 \qquad K = 48^\circ\ 25'\ 29''.13$$

$$\Pi = 247\ 40\ 26.90 \qquad K' = 47\ 48\ 1.33$$

$$\Pi' = 199\ 33\ 34.13$$

$$\text{Log } k = 9.9991720$$

$$\text{Log } C = 6.4491253 \qquad \text{„ } k' = 9.9933526$$

Secular Perturbations.

$$\left[\frac{de}{dt}\right]_{00} = -0''.000547 \qquad \left[\frac{d\Omega}{dt}\right]_{00} = -0''.108987$$

$$\left[\frac{d\chi}{dt}\right]_{00} = +0''.096102 \qquad \left[\frac{d\pi}{dt}\right]_{00} = +0''.094236$$

$$\left[\frac{di}{dt}\right]_{00} = +0''.000011 \qquad \left[\frac{dL}{dt}\right]_{00} = +1''.926030$$

$$A_1^{(s)} \sin\phi + B_0^{(c)} \cos\phi = -0.000000009$$

IV. Mars.

Elements.

$$n' = 689050''.784$$

$$\text{Log } e' = 8.96973284$$

$$\left.\begin{array}{rl} \pi' = & 333\ 17'\ 51''.74 \\ \Omega' = & 48\ 23\ 54.59 \\ i' = & 1\ 51\ 2.24 \end{array}\right\} 1850$$

$$\text{Log } a' = 0.1828971$$

$$m' = 1/3093500$$

$$\text{I} = 9^\circ\ 6'\ 33''.95 \qquad \text{K} = 175^\circ\ 21'\ 16''.67$$

$$\Pi = 241\ 23\ 55.82 \qquad \text{K}' = 174\ 49\ 10.35$$

$$\Pi' = 66\ 18\ 46.43$$

$$\text{Log } k = 9.9953869$$

$$\text{Log C} = 8.3052599 \qquad ,, \quad k' = 9.9991198$$

Secular Perturbations.

$$\left[\frac{de}{dt}\right]_{00} = +0''.000068 \qquad \left[\frac{d\Omega}{dt}\right]_{00} = -0''.039884$$

$$\left[\frac{d\chi}{dt}\right]_{00} = +0''.064691 \qquad \left[\frac{d\pi}{dt}\right]_{00} = +0''.064008$$

$$\left[\frac{di}{dt}\right]_{00} = +0''.000857 \qquad \left[\frac{dL}{dt}\right]_{00} = +0''.238781$$

$$A_1^{(s)} \sin\phi + B_0^{(c)} \cos\phi = +0.0000000007$$

Owing to the inequality of the quantities Σ_1 and Σ_2, for several of the functions, it was decided to divide the orbit of Ceres into another sixteen equal parts and make a separate calculation.

The results of the summations of the several functions in each case are given below the tabular statement; they are denoted by Σ_3. A comparison of these, with the quantity $\Sigma_1 + \Sigma_2$, completely verifies the accuracy of the first investigation.

The secular perturbations given above are determined from the first computed coefficients, as no alteration would take place by combining the results for the thirty-two divisions. The residual of the check equation for testing the accuracy of the perturbations in the plane of the orbit for the second division is $+0.000000002$.

V. Jupiter.

Elements.

$$n' = 109256''.62552$$
$$\text{Log } e' = 8.68354330$$

$$\left.\begin{aligned} \pi' &= 11^\circ\ 54'\ 31''.67 \\ \Omega' &= 98\ 56\ 19.79 \\ i' &= 1\ 18\ 42.10 \end{aligned}\right\} 1850$$

$$\text{Log } a' = 0.7162374$$
$$m' = 1/1047.879$$

$$I = 9^\circ\ 22'\ 50''.37 \qquad K = 136^\circ\ 19'\ 14''.71$$
$$\Pi = 250\ 10\ 47.57 \qquad K' = 136\ 53\ 10.58$$
$$\Pi' = 113\ 34\ 30.27$$

$$\text{Log } k = 9.9950989$$
$$\text{Log } C = 8.7995614 \qquad ,, \quad k' = 9.9990752$$

Secular Perturbations.

$$\left[\frac{de}{dt}\right]_{00} = -\ 0''.675238 \qquad \left[\frac{d\Omega}{dt}\right]_{00} = -52''.157759$$

$$\left[\frac{d\chi}{dt}\right]_{00} = +56''.772540 \qquad \left[\frac{d\pi}{dt}\right]_{00} = +55''.879400$$

$$\left[\frac{di}{dt}\right]_{00} = -\ 0''.577398 \qquad \left[\frac{dL}{dt}\right]_{00} = -56''.026115$$

$$A_1^{(s)} \sin\phi + B_0^{(c)} \cos\phi = -0.000000001$$

VI. Saturn.

Elements.

$$n' = 43996''.21506$$
$$\text{Log } e' = 8.74865503$$

$$\left.\begin{aligned} \pi' &= 90^\circ\ 6'\ 41''.37 \\ \Omega' &= 112\ 20\ 40.05 \\ i' &= 2\ 29\ 40.19 \end{aligned}\right\} 1850$$

$$\text{Log } a' \quad 0.97949564$$
$$m' \quad 1/3501.6$$

$$\mathrm{I} = 8^{\circ}\,35'\,27''{\cdot}85 \qquad \mathrm{K} = 58^{\circ}\,40'\,26''{\cdot}61$$
$$\Pi = 256\ 26\ 31{\cdot}11 \qquad \mathrm{K}' = 58\ 17\ 41{\cdot}41$$
$$\Pi' = 197\ 57\ 23{\cdot}97$$

$$\log k = 9{\cdot}9995389$$
$$\log \mathrm{C} = 9{\cdot}4563013 \qquad ,, \quad k' = 9{\cdot}9955700$$

Secular Perturbations.

$$\left[\frac{de}{dt}\right]_{00} = -0''{\cdot}030004 \qquad \left[\frac{d\Omega}{dt}\right]_{00} = -1''{\cdot}410009$$

$$\left[\frac{d\chi}{dt}\right]_{00} = +1''{\cdot}339545 \qquad \left[\frac{d\pi}{dt}\right]_{00} = +1''{\cdot}315400$$

$$\left[\frac{di}{dt}\right]_{00} = -0''{\cdot}040972 \qquad \left[\frac{d\mathrm{L}}{dt}\right]_{00} = -2''{\cdot}122041$$

$$\mathrm{A}_1^{(s)} \sin\phi + \mathrm{B}_0^{(c)} \cos\phi = -0{\cdot}000000007$$

VII. Uranus.

Elements.

$$n' = 15425''{\cdot}752$$
$$\log e' = 8{\cdot}67139132$$
$$\left.\begin{array}{l}\pi' = 168\ 15\ 6{\cdot}70\\ \Omega' = 73\ 14\ 8{\cdot}00\\ i' = 0\ 46\ 20{\cdot}54\end{array}\right\} 1850$$
$$\log a' = 1{\cdot}2831044$$
$$m' = 1/22800$$

$$\mathrm{I} = 9^{\circ}\,51'\,11''{\cdot}74 \qquad \mathrm{K} = 340^{\circ}\,15'\,40''{\cdot}28$$
$$\Pi = 247\ 4\ 47{\cdot}40 \qquad \mathrm{K}' = 340\ 10\ 5{\cdot}55$$
$$\Pi' = 266\ 51\ 55{\cdot}71$$

$$\log k = 9{\cdot}9935658$$
$$\log \mathrm{C} = 9{\cdot}9089914 \qquad ,, \quad k' = 9{\cdot}9999810$$

Secular Perturbations.

$$\left[\frac{de}{dt}\right]_{00} = +0''{\cdot}000195 \qquad \left[\frac{d\Omega}{dt}\right]_{00} = -0''{\cdot}026973$$

$$\left[\frac{d\chi}{dt}\right]_{00} = +0''.023392 \qquad \left[\frac{d\pi}{dt}\right]_{00} = +0''.022930$$

$$\left[\frac{di}{dt}\right]_{00} = +0''.000000,2 \qquad \left[\frac{dL}{dt}\right]_{00} = -0''.036902$$

$$A_1^{(s)} \sin\phi + B_0^{(c)} \cos\phi = +0.00000000002$$

VIII. Neptune.

Elements.

$$n' = 7864''.935$$

$$\text{Log } e' = 7.9292247$$

$$\left.\begin{aligned} \pi' &= 43^\circ\ 17'\ 30''.30 \\ \Omega' &= 130\ \ 7\ 31.83 \\ i' &= \ \ 1\ 47\ \ 1.68 \end{aligned}\right\} 1850$$

$$\text{Log } a' = 1.4781414$$

$$m' = 1/19700$$

$$I = 9^\circ\ 33'\ 3''.35 \qquad K = 104^\circ\ 38'\ 4''.92$$

$$\Pi = 255\ 51\ 14.32 \qquad K' = 105\ 18\ 52.87$$

$$\Pi' = 150\ 52\ 49.92$$

$$\text{Log } k = 9.9985797$$

$$\text{Log } C = 8.8147322 \qquad \text{,,} \quad k' = 9.9953889$$

Secular Perturbations.

$$\left[\frac{de}{dt}\right]_{00} = +0''.000014 \qquad \left[\frac{d\Omega}{dt}\right]_{00} = -0''.007647$$

$$\left[\frac{d\chi}{dt}\right]_{00} = +0''.007602 \qquad \left[\frac{d\pi}{dt}\right]_{00} = +0''.007471$$

$$\left[\frac{di}{dt}\right]_{00} = -0''.000213 \qquad \left[\frac{dL}{dt}\right]_{00} = -0''.010975$$

$$A_1^{(s)} \sin\phi + B_0^{(c)} \cos\phi = -0.00000000001$$

Secular Perturbations of Minor Planet Ceres, arising from the actions of the Eight Major Planets of the Solar System.

Planet	$\left[\frac{de}{dt}\right]_{00}$	$\left[\frac{d\chi}{dt}\right]_{00}$	$\left[\frac{di}{dt}\right]_{00}$	$\left[\frac{d\Omega}{dt}\right]_{00}$	$\left[\frac{d\pi}{dt}\right]_{00}$	$\left[\frac{dL}{dt}\right]_{00}$
Mercury	−0″·000020	+ 0″·000521	+0″·000047	− 0″·000257	+ 0″·000517	+ 0″·076247
Venus	−0·000025	+ 0·037022	+0·000219	− 0·026580	+ 0·036567	+ 1·395618
Earth	−0·000547	+ 0·096102	+0·000011	− 0·108987	+ 0·094236	+ 1·926030
Mars	+0·000068	+ 0·064691	+0·000357	− 0·039884	+ 0·064008	+ 0 238781
Jupiter	−0·675238	+56·772540	−0·577398	−52·157759	+55·879400	−56·026115
Saturn	−0·030004	+ 1·339545	−0·040972	− 1·410009	+ 1·315400	− 2·122041
Uranus	+0·000195	+ 0·023392	+0·000000	− 0·026973	+ 0·022930	− 0·036902
Neptune	+0·000014	+ 0·007602	−0·000213	− 0·007647	+ 0·007471	− 0·010975
Summation	−0·705557	+58·341415	−0·617949	−53·778096	+57·420529	−54·559357

Total Secular Perturbations of Ceres.

$$\left[\frac{de}{dt}\right]_{00} = -0''\cdot70556 \qquad \left[\frac{d\Omega}{dt}\right]_{00} = -53''\cdot77810$$

$$\left[\frac{d\chi}{dt}\right]_{00} = +58''\cdot34142 \qquad \left[\frac{d\pi}{dt}\right]_{00} = +57''\cdot42053$$

$$\left[\frac{di}{dt}\right]_{00} = -0''\cdot61795 \qquad \left[\frac{dL}{dt}\right]_{00} = -54''\cdot55936$$

Sydney: 1907 *March* 1.

[*The Tables to accompany Mr. Merfield's paper are bound and placed in the Library.*]

Diagram showing the positions of Jupiter's Satellites VI. and VII., from photographs taken at the Royal Observatory, Greenwich, during the Opposition 1905-6.

Diagram showing the positions of Jupiter's Satellites VI. and VII., from photographs taken at the Royal Observatory, Greenwich, during the Opposition 1906-7.

On the Measurement of a Meteor Trail on a Photographic Plate.
By H. H. Turner, D.Sc., F.R.S., Savilian Professor.

1. On August 22, 1907, Mr. F. W. Longbottom, of Haslemere, Queen's Park, Chester, sent me the print of a nebula photograph across which a meteor had flashed, asking for advice about the measurement. I have not seen any note on the easiest way of utilising such trails, which have already appeared in a good many photographs, and will doubtless occur in a good many more; and the following method may be found useful in other cases.

2. The rule is simply—measure on any convenient uniform scale, and by any convenient method, the distances of any known stars from the trail. (Three stars are theoretically sufficient, but more will give better results.) These measures will give the desired information.

3. The information obtainable is the position of the pole of the trail. The trail is assumed to be part of a straight line on the plate or of a great circle on the sphere. We cannot determine the radiant from a single trail, only the great circle on which the radiant lies; and this is conveniently specified by its pole, in R.A. and Decl. A_m and D_m say. If we can find other trails belonging to the same radiant, their poles will lie on a great circle of which the radiant is the pole.

4. Let (A, D) be the co-ordinates of the plate centre; (ξ, η) the standard co-ordinates of any point on the plate, *expressed in parts of the radius*, the R.A. and Decl. being (α, δ). If (α, δ) lies on the meteor trail, it is 90° distant from (A_m, D_m), and hence

$$\sin\delta \sin D_m + \cos\delta \cos D_m \cos(\alpha - A_m) = 0 \quad . \qquad (1)$$

Now (α, δ) may be expressed in terms of (ξ, η) by the following formulæ (*Monthly Notices*, lxiv. p. 648):—

$$\frac{\cos\delta \sin(\alpha - A)}{\xi} = \frac{\sin\delta}{\sin D + \eta \cos D} = \frac{\cos\delta \cos(\alpha - A)}{\cos D - \eta \sin D} \qquad (2)$$

and since we may re-write (1) in the form

$$d \cos\delta \sin(\alpha - A) + q \sin\delta + r \cos\delta \cos(\alpha - A) = 0 \qquad (3)$$

where

$$d = \cos D_m \sin(A_m - A), \; q = \sin D_m, \; r = \cos D_m \cos(A_m - A) \qquad (4)$$

It may also be written

$$d.\xi + q(\sin D + \eta \cos D) + r(\cos D - \eta \sin D) = 0 \quad . \qquad (5)$$

or

$$d.\xi + e.\eta + f = 0 \quad . \quad . \quad . \quad . \qquad (6)$$

where q and r are replaced by e and f such that

$$\left.\begin{aligned} e &= q \cos D - r \sin D = \sin D_m \cos D - \cos D_m \sin D \cos(A_m - A) \\ f &= q \sin D + r \cos D = \sin D_m \sin D + \cos D_m \cos D \cos(A_m - A) \end{aligned}\right\} \qquad (7)$$

The equation (6) is the equation to the meteor trail on the plate in standard co-ordinates.

5. Now let (ξ_s, η_s) be the standard co-ordinates of any star, and let us measure, in terms of any convenient unit, its distance p_s from the meteor trail. Then

$$k'.p_s\,(d^2+e^2)^{\frac{1}{2}} = d\xi_s + e\eta_s + f$$

where k' is a constant representing the arbitrary scale value; and we can replace $k'\,(d^2+e^2)^{\frac{1}{2}}$ by a new arbitrary constant k^{-1}. Thus

$$p_s = kd.\xi_s + ke.\eta_s + kf$$

From the measures of three different stars for which (ξ_s, η_s) are known we get kd, ke, kf. We can utilise the measures of other stars by any of the well-known processes.

6. Then from (7) we get kq and kr; and from (4) we have

$$\tan\,(A_m - A) = \frac{d}{r} = \frac{kd}{kr} \qquad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

$$\tan D_m = \frac{q}{\pm(d^2+r^2)^{\frac{1}{2}}} = \frac{kq}{\pm(k^2d^2+k^2r^2)^{\frac{1}{2}}} \qquad . \quad . \quad (9)$$

which give A_m and D_m, since A is known.

7. For the trail caught by Mr. Longbottom on August 4, 1907, while he was photographing N.G.C. 6960, with a 12¼-in. reflector of 24-in. focus, exposure 45 minutes; time of meteor $10^h\ 52^m$: it will be a sufficiently good approximation (as the scale is small and the star images large owing to coma and a small driving error) to take as the plate-centre that used for the plate of this region in the Oxford Astrographic Catalogue, viz.—

$$A = 20^h\ 42^m \qquad D = +30^\circ \qquad (1900{\cdot}0)$$

There was no difficulty in identifying several stars from the Cambridge Catalogue, and a rough reduction from these made it easy to identify on the reflector photograph the other stars shown on the Oxford plate in the neighbourhood. The following measures were then made by Mr. Bellamy:—

		Oxford.			
No. in +30°.	Diam.	x	y	p	O−C.
61506	14	7·785	16·391	+1·12	·00
61507	12	8·018	·418	+1·09	·00
61508*	22	8·616	·508	+0·99	·00
61509	14	10·580	·420	+0·91	−·01
61510	20	11·184	·439	+0·83	+·01
61511	22	11·622	·228	+0·92	+·01
61512*	40	11·715	·407	+0·83	−·01
61513	20	12·689	·544	+0·65	+·01
61514	14	12·725	16·360	+0·77	·00

No. in +30°.	Diam.	x	y	p	O−C.
61542	11	8·444	17·446	+0·44	+·02
61543	12	10·563	410	+0·32	·00
61545	12	10·993	·952	−0·04	·00
61546*	90	11·292	·138	+0·45	−·02
61547	13	15·090	17·401	−0·03	−·02
61580*	35	8·695	18·422	−0·14	−·01
61581	40	9·390	·385	−0·16	−·02
61582	15	9·975	·363	−0·21	·00
61583	20	11·096	·165	−0·17	−·01
61584	12	11·256	·156	−0·18	·00
61585	17	12·179	·631	−0·52	−·02
61586	14	13·643	·877	−0·78	−·01
61587	30	14·341	·929	−0·88	·00
61588	24	15·450	18·888	−0·92	−·02
61606*	30	9·744	19·337	−0·77	·00
61607	12	12·222	·708	−1·17	−·01
61608	12	13·189	·027	−0·84	−·01
61609*	38	14·796	·524	−1·27	+·01
61610	14	15·290	19·659	−1·46	+·08

Measures of 61610 marked as very faint, ? a star.

The values of x and y are not standard co-ordinates but the measures on the Oxford plate; but they can be readily converted into standard co-ordinates by means of the formulæ given at the plate-heading in the Oxford Catalogue. No doubt it is scarcely necessary to measure so many stars, but it seemed possible that there might be systematic error depending on the shape of the star images with a reflector of so short a focus; and thus stars of different magnitudes might give different results.

8. The constants in the linear relation

$$d'x + e'y + f' = p$$

were then found to be as follows:—

$$d' = -·0762, \quad e' = -·5915, \quad f' = +11·416$$

We may omit the last figure as probably not justified by the measures and write

$$d' = -·076, \quad e' = -·592, \quad f' = +11·42$$

With these values the column O − C was formed, and it will be seen that the effect of the brightness of the star is not large.

9. The formulæ for getting standard co-ordinates from x and y are (*see* heading of plate)

$$\xi = x - 13 + ·00054x - ·00081y + ·5124$$
$$\eta = y - 13 + ·00061x + ·00043y + ·1011$$

Let us write

$$\xi_0 = \xi + 13 - \cdot51 = \xi + 12\cdot49$$
$$\eta_0 = \eta + 13 - \cdot10 = \eta + 12\cdot90$$

adopting the standard of accuracy found sufficient above.

Then $(x - \xi_0)$, $(y - \eta_0)$ differ by less than ·001 of x and y, and hence we may neglect squares of these differences. Thus

$$x = \xi_0 - \cdot0005\xi_0 + \cdot0008\eta_0 = \xi - \cdot0005\xi + \cdot0008\eta + 12\cdot49$$
$$y = \eta_0 - \cdot0006\xi_0 - \cdot0004\eta_0 = \eta + \cdot0006\xi + \cdot0004\eta + 12\cdot91$$

Hence
$$p = -\cdot076\xi - \cdot592\eta + 11\cdot42 - \cdot076 \times 12\cdot49 - \cdot592 \times 12\cdot91$$
$$= -\cdot076\xi - \cdot592\eta + 2\cdot84$$

But ξ η are expressed in reseau intervals, and it was assumed in § 4 that they were in parts of the radius. We must multiply their coefficients by 687·6.

10. Hence as in Eq^{n}. (7)

$$kq \cos D - kr \sin D = ke = -\cdot592 \times 687\cdot6 = -407\cdot1$$
$$kq \sin D + kr \cos D = kf = +2\cdot84$$

$$kq = -407 \times \cdot866 + 2\cdot84 \times 0\cdot500 = -351$$
$$kr = +407 \times \cdot500 + 2\cdot84 \times 0\cdot866 = +206$$

and
$$\tan (A_m - A) = \frac{kd}{kr} = \frac{-\cdot076 \times 688}{+206} = -\cdot254$$

$$\therefore \quad A_m - A = -14^\circ 15' \text{ or } +165^\circ 45'$$

We shall always get an ambiguity, as there are two poles to the trail. But when we choose one or other of these values, we settle the ambiguity of Eq^{n}. (9), which may be otherwise written

$$\tan D_m = \frac{kq}{kr} \sec (A_m - A)$$

$$= -\frac{351}{206} \times 1\cdot032 = -1\cdot758 \text{ taking } (A_m - A) = -14^\circ 15'$$

$$D_m = -60^\circ 22'$$

Hence the two poles are for 1900·0

$A_m = 20^h\ 42^m - 57^m\ 0^s$
$\quad = 19^h\ 45^m\ 0^s$
$D_m = -60^\circ\ 22'$

and

$A_m = 7^h\ 45^m\ 0^s$
$D_m = +60^\circ\ 22'$

They may be brought up to date by well known rules.

Note on a Meteoric Shower. (*The August Draconids.*)

By W. F. Denning.

On 1907 August 15 I saw five meteors during a watch of forty minutes from a radiant at 288° + 61°. One of them was stationary at that point. On August 26 at 9^h 18^m I observed a brilliant member of the same shower falling from 231° + 57° to 213° + 50°, and showing some curious fluctuations in its light. On August 28, during a short period of clear sky, I recorded two other meteors from the same radiant. On August 15, Mr. H. Corder saw a Draconid equal to Mars flashing out with an orange colour at 288° − 10°, and falling 8° further in a vertical path directed from a point one degree west of β Cygni.

The shower is evidently active between August 15 and 28, and I recognised it between these dates in the years 1887, 1899, and 1900. Mr. Corder had also seen it pretty richly manifested on 1879 August 16 from 286° + 61° (10 meteors).

This display of Draconids, coming, as it does, concurrently with the rapidly declining stages of the great Perseid shower, deserves special mention, and particular efforts should be made in future years to re-observe it. In 1879 August 21 to 25, of 225 meteors which I recorded, no less than 56 were Draconids, and nearly all of them were bright, slow-moving objects with yellow trains. During the twenty-eight years which have passed since 1879 I have never seen the shower richly exhibited until last month, when, however, my observations were very imperfect on account of ill-health. Particulars of this evidently prominent and periodically visible system of meteors, as it appeared in 1879, will be found in the *Monthly Notices*, vol. xl. pp. 127–8, and in *The Observatory*, vol. iii. pp. 172–3.

Bishopston, Bristol:
1907 *September* 1.

On Trigonometrical Differences of Altitude.

By G. Tyrrell McCaw, M.A.

In the present methods in use in practical geodesy for determining the difference of altitude of two stations on the Earth's surface, it is common to assume that the vertical refraction at both ends of the line joining two stations is the same. Sometimes even the error seems to be made of implicitly assuming that refraction is eliminated by simultaneous and reciprocal observations at the two ends.

The refraction at each station is commonly regarded as a linear factor of the "contained angle" subtended by the stations at the Earth's centre; or, in other words, is considered as being directly proportional to the distance between the two stations projected on the geodetic surface. The refraction r is therefore expressed thus—

$$r = k \cdot \psi,$$

ψ being the contained angle and k the so-called "coefficient of refraction."*

Numerous experiments in various parts of the world have shown that this coefficient is by no means constant, not even for the same station. Thus in the United Kingdom, though in 72 cases the value lay between 0·0733 and 0·0804, among 144 cases the values varied between the extremes of 0·0320 and 0·1058. Even in the clear air of mountain heights, where one usually obtains consistent results, there may be wide differences. Thus in the line Ben Lomond to Ben Nevis, the value on Ben Lomond was 0·0719, while on Ben Nevis it was 0·0942.

In Western America, when the refraction at a single station was investigated, the coefficient was found to have a diurnal range as great as 0·04 in some cases. Periods of rapid change occurred about an hour before sunrise and an hour after sunset. The time of *maximum* was about 3 a.m., and the time of *minimum* varied at different stations between 10 a.m. and 4 p.m., the hour from 2 to 3 p.m. marking apparently the mean period. On the line Mt. Diablo—Martinez East, the value at 3 p.m. at the former station (height 1173 metres) was 0·0653, and at the latter (57 m.) 0·1007, while at the latter the value rose to 0·1415 at 3 a.m. The value for the interior of the continent was about 0·065, over parts of the sea near the Atlantic coast about 0·078, and over parts of the sea near the Pacific coast about 0·085. Generally speaking, low elevations gave higher values and greater range; higher values were also obtained in the excessive moisture of the sea-coast. The range of temperature seems chiefly to determine the form of the curve which represents the diurnal variation of the coefficient; height or moisture, its position.

* In Continental practice it is the custom to apply the symbol k to the ratio of the total refraction to the contained angle.

Taking the mean value of the two stations on a line, the Coast Survey obtained the following results :—

	Jackson Butte (714 m.)—Round Top (3174 m.) (Inland).	Sea Horizon—Ragged Mt. (397 m. (Atlantic coast).	Martinez East (57 m.)—Mt. Diablo (1173 m.) (Pacific ocean).
Daily Mean,	0·0646	0·0849	0·1000
Diurnal Range,	0·0168	0·0293	0·0333

In the computations of the great American Arc of Parallel 39°, the mean coefficients for the various lines in the western portion of the arc were tabulated, the mean heights of the stations and mean temperatures also being recorded. These results seemed to suggest an empirical formula of the form—

$$k = k_0 + (t - t_0)x + (h - h_0)y ,$$

t_0 and h_0 being the mean temperature (Centigrade) and height (in hectometres) of all the stations in a given area of the triangulation.

For the more eastern area $k_0 = 0{\cdot}0534$, $t_0 = 9^{\circ}{\cdot}9$, $h_0 = 37{\cdot}7$
„ „ western „ $= 0{\cdot}0578$, $= 11^{\circ}{\cdot}2$, $= 32{\cdot}5$

Forming the equations for all the observations in each area, the following values of x and y were obtained by mean squares :—

For the more eastern area $x = 0{\cdot}00036$, $y = 0{\cdot}00087$
„ „ western „ $= 0{\cdot}00081$, $= 0{\cdot}00091$

The agreement between the observed and computed values was, in general, fairly good.

Over the hot plains of India much greater discrepancies were observed. In one case a depression of $4'\,52''{\cdot}6$ at 4.30 p.m. changed to an elevation of $2'\,24''{\cdot}0$ at 10.50 p.m., the stations being only 10·5 miles apart. The refraction had sometimes a negative value, and signals which were invisible during the day were seen above the horizon at sunset. The coefficient in India actually ranged from $-0{\cdot}09$ to $+1{\cdot}21$.

In Cape Colony and Natal the refraction was more constant, the extreme values of the coefficient being found to be 0·045 and 0·106, but by no means all the lines were computed. The value was seen to increase by about 0·00045 per mile for distances between 20 and 60 miles—a result which shows that the refraction is not a linear factor of the distance.

Careful observations in France indicated that refraction there is greatest about daybreak, and then diminishes very rapidly till 8 a.m., and from that very slowly till 10 a.m. Thence the refraction remains nearly constant till 4 p.m., after which it begins again to increase.

Very few experiments have been made with a view to determine seasonal variation, but there is evidence enough to show that refraction changes very considerably with the season.

Enough has been said to prove how very variable the coefficient may be. It is otherwise obvious, *à priori*, that the refraction at a

point in a hot, low, moist plain must be very different from that on a cool, dry, mountain height. Indeed there is a very special reason for this refraction remaining even so constant as it is: in primary triangulation work, practically all measurement of vertical angle is made within the range of 87° and 93° zenith distance, and the great majority of the observations are confined within 89° 45′ and 90° 45′—a range of only one degree.

One of the practical methods devised to overcome the difficulty of the variability of refraction is that which assumes that the coefficient is constant for a given station rather than for the extremities of a line. This is also a fairly extravagant hypothesis. It ignores the variation of zenith distance with which the refraction is doubtless in some way connected; it ignores the varying length of the lines by which the refraction is affected in some measure, as shown in South Africa; it ignores, further, those fortuitous variations which take place from moment to moment, due to rain, clouds, wind, heat waves, etc., the effect of which in an individual measure may have a preponderating effect on the mean of a series of observations.

The actual method of determining the coefficients on this assumption is as follows:—If $k_1, k_2, k_3, \ldots\ldots$ be the mean values of the coefficients at the stations $P_1, P_2, P_3 \ldots\ldots$ respectively, then it is easily seen that these coefficients are connected by equations of the form

$$k_1 + k_2 = \text{a constant},$$

the constant being determined from the observations; forming the equations for all the stations in a circuit, the values of $k_1, k_2, k_3 \ldots\ldots$ are determined.

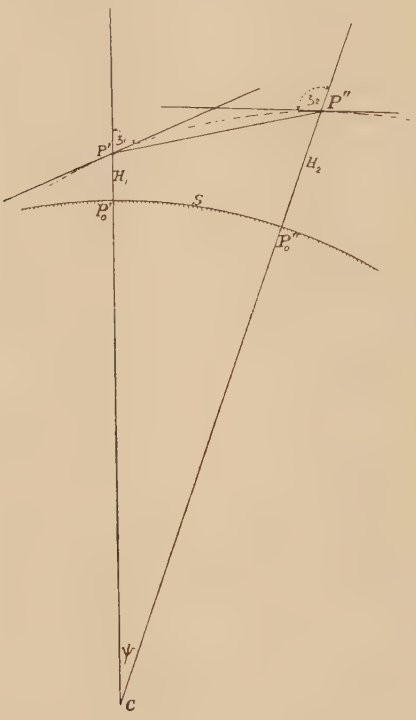
It is, of course, well recognised that it is an entirely gratuitous assumption to express the refraction at either end of a line, or the total refraction, as simply proportional to the arc between the two stations. It is, therefore, in more refined methods, usual to endeavour to find an expression for k which will introduce the necessary meteorological conditions. These investigations lead to equations almost unmanageable in practice, and depend on atmospheric hypotheses not generally recognised.

In all present methods, so far as the writer is aware, there are assumptions which can with difficulty be defended on theoretical grounds, or on the ground that the coefficients adopted are found by experience to give concordant results. Recognising this fact, the Seventh Congress of the International Geodetic Association, in 1883, after hearing a report from Dr. Bauernfeind, expressed the desire that the various States which contribute to the Association should undertake exact investigations to determine the influence of the varying conditions of ground and climate on the terrestrial refraction.

As the problem remains unsolved, the writer offers the following theoretical solution, based on generally accepted physical

laws and recognised hypotheses. In this solution it will be seen that the use of the coefficient k has been entirely abandoned.

It is necessary to premise at the outset that the observations at the ends of the line are reciprocal and simultaneous. The temperature and pressure must be observed at both stations with standardised instruments. For the present no consideration will be taken of the effect of aqueous vapour; the influence of this vapour may be subsequently investigated.



In the figure, P', P'' are two stations on the Earth's surface; P_0', P_0'' their projections on the ellipsoid of reference; the mean radius of curvature of the ellipsoid along the line between P_0' and P_0'' is R; Z_1, Z_2 are the true, and ζ_1, ζ_2 the observed, zenith distances of the mutually observed points; the contained angle $P'OP''$ is ψ; the length of the arc $P_0'\ P_0''$ is S; H_1, H_2 are the heights of the two stations above the spheroid, and $H_2 - H_1 = h$, the height-difference.

We adopt the recognised hypothesis that the air in its normal condition consists of spherical strata, the density of each layer being constant, and varying continuously from layer to layer. Then, if a beam of light pass through media of continuously

varying density, the density and refractive index of a layer being any function whatever of the distance from a fixed point, we have the well-known relation

$$\mu.r.\ \sin\phi = a\ constant,$$

where

μ is the absolute index of refraction of any stratum,
r the distance of that stratum from the fixed origin,
ϕ the angle between the vector r and the tangent to the path of the beam at the point where it cuts the stratum whose index is μ.

Applying this law to the present case

$$\mu_1(R+H_1)\sin\zeta_1 = \mu_2(R+H_2)\sin\zeta_2$$

whence

$$\frac{R+H_2}{R+H_1} = \frac{\mu_1 \sin\zeta_1}{\mu_2 \sin\zeta_2} \quad . \quad . \quad . \quad . \quad (1)$$

Put the latter $= \omega$.

Then $$H_2 - H_1 = h = (R+H_1)(\omega - 1) \quad . \quad . \quad (2)$$

Thus the height-difference is known if we know ω, that is, if the ratio $\mu_1 : \mu_2$ is known.

Before proceeding to investigate this ratio we shall consider two particular cases.

From the geometrical conditions of the figure we have obviously

$$\frac{R+H_2}{R+H_1} = \frac{\sin Z_1}{\sin Z_2},$$

whence

$$H_2 - H_1 = h = 2(R+H_1)\frac{\sin\frac{1}{2}(Z_1 - Z_2)\cos\frac{1}{2}(Z_1 + Z_2)}{\sin Z_2} \quad (3)$$

which reduces to

$$h = 2(R+H_1)\sin\tfrac{1}{2}\psi.\frac{\sin\frac{1}{2}(Z_2 - Z_1)}{\cos\frac{1}{2}(Z_2 - Z_1 + \psi)} \quad . \quad (4)$$

which is the rigorous expression for the height-difference if the difference of the true zenith distances be known.

Consider first the particular case where the refraction at both ends of the line is the same.

Then, since $Z_1 - \zeta_1 = Z_2 - \zeta_2$, equation (4) becomes

$$h = 2(R+H_1)\sin\tfrac{1}{2}\psi.\frac{\sin\frac{1}{2}(\zeta_2 - \zeta_1)}{\cos\frac{1}{2}(\zeta_2 - \zeta_1 + \psi)} \quad . \quad (5)$$

which is the rigorous expression for h when the above assumption is supposed to hold good, the plumbline being uninfluenced by local attraction at either station, and the mean surface of curvature of the geoid between the two stations being regarded as part of a sphere.

Again, suppose that $\mu_1 = \mu_2$, *i.e.* that the index of refraction at both stations is the same; then equation (1) becomes

$$\frac{R + H_2}{R + H_1} = \frac{\sin \zeta_1}{\sin \zeta_2},$$

wherefore the height-difference is expressed by the equation (3), in which the observed zenith distance ζ is substituted for the true zenith distance Z.

To proceed with the general investigation, it is necessary to determine the ratio $\mu_1 : \mu_2$.

Suppose that a ray of light passes from a vacuum into a gas whose absolute index of refraction is μ and density ρ. Then if the density be varied, the index of refraction varies according to the formula

$$\mu - 1 = c.\rho, \text{ where } c \text{ is a constant} \quad . \quad . \quad (6)$$

This, the well-known law of Gladstone and Dale, is that which is generally accepted for solids, liquids, and gases. In the case of gases, however, where μ is nearly equal to unity, some have supposed that

$$\mu^2 - 1 = c.\rho$$

more nearly represents the true law.* We shall adopt Gladstone's law; but even should a somewhat different formula be discovered in the future, it is obvious that the present investigation is readily modifiable accordingly.

It only remains to find the density in terms of the temperature and pressure according to the usual relations dependent on the Boyle-Marriotte-Charles law.

Let p_1, p_2 be the atmospheric pressures at the stations P', P''.

t_1, t_2 „ „ temperatures „ „

b_1, b_2 „ heights of the barometers „ „

g_1, g_2 „ accelerations of gravity „ „

τ_1, τ_2 „ temperatures indicated by the thermometers attached to the mercurial columns at P', P'' when the corresponding atmospheric temperatures are t_1, t_2.

σ_0 be the density of mercury at 0° C.

β „ coefficient of expansion of mercury.

Then we have the following relations:

$$\begin{aligned} p_1 &= \kappa.\rho_1.(1 + \alpha.t_1) \\ p_2 &= \kappa.\rho_2.(1 + \alpha.t_2) \end{aligned} \quad . \quad . \quad . \quad (7)$$

But

$$\begin{aligned} p_1 &= g_1.\sigma_0.(1 - \beta.\tau_1).b_1 \\ p_2 &= g_2.\sigma_0.(1 - \beta\,\tau_2).b_2 \end{aligned} \quad . \quad . \quad . \quad (8)$$

Accordingly

$$\begin{aligned} \rho_1 &= \frac{g_1.\sigma_0.(1 - \beta.\tau_1).b_1}{\kappa(1 + \alpha.t_1)} \\ \rho_2 &= \frac{g_2\,\sigma_0.(1 - \beta.\tau_2).b_2}{\kappa(1 + \alpha.t_2)} \end{aligned} \quad . \quad . \quad . \quad (9)$$

* This latter relation is attributed to Biot and Arago.

To put these into more workable forms, let T_1, T_2 be the absolute temperatures, so that

$$T_1 = \frac{1}{\alpha} + t_1, \quad T_2 = \frac{1}{\alpha} + t_2;$$

and let

$$\mathfrak{T}_1 = \frac{1}{\beta} - \tau_1, \quad \mathfrak{T}_2 = \frac{1}{\beta} - \tau_2;$$

then

$$\omega = \frac{\mu_1 \sin \zeta_1}{\mu_2 \sin \zeta_2} = \frac{(1 + c.\rho_1).\sin \zeta_1}{(1 + c.\rho_2).\sin \zeta_2}.$$

Substituting ρ_1 and ρ_2 from (9).

$$\omega = \frac{\kappa a + c\sigma_0 \beta g_1 b_1 \dfrac{\mathfrak{T}_1}{T_1}}{\kappa a + c\sigma_0 \beta g_2 b_2 \dfrac{\mathfrak{T}_2}{T_2}} \cdot \frac{\sin \zeta_1}{\sin \zeta_2} \quad . \quad . \quad (10)$$

But g_1, g_2 may generally be put equal to g, where g is computed in the first instance by the formula

$$g = g_0 \cdot \frac{R^2}{(R + H)^2},$$

g_0 being the acceleration of gravity at sea-level at the mean latitude of the survey, and H the average height of the stations. This will usually be sufficiently exact if for no other reason than that g_1, g_2 will often be considerably affected by the distribution of Earth-mass in the vicinity of the stations. Hence putting

$$\frac{\kappa.a}{c.\sigma_0.\beta.g} = A,$$

we have finally

$$\omega = \frac{A + b_1 \dfrac{\mathfrak{T}_1}{T_1}}{A + b_2 \dfrac{\mathfrak{T}_2}{T_2}} \cdot \frac{\sin \zeta_1}{\sin \zeta_2} \quad . \quad . \quad . \quad (11)$$

If the units throughout be centimetres and degrees Centigrade,

A is about 5,262,250 cms.

Thus ω is completely determined from the observed zenith distances and the temperatures and pressures at the two stations. This value of ω substituted in equation (2)

$$h = (R + H_1)(\omega - 1)$$

gives the difference of height of the two stations, subject to the usual correction for "eye and object."

. . . . . .

It is obvious that, if the air is not in its normal condition, if it is locally disturbed by storms, rain, cloud, excessive moisture, and such-like, the distribution of density in spherical strata may be considerably upset, and the theory will no longer hold good. Should, however, such abnormal conditions occur, they will generally reveal themselves at one or both of the stations by considerable perturbations of the thermometer or barometer. Moreover, it must be remembered that the theory of celestial refraction is vitiated by the same disturbances, though it must be granted that these disturbances are more likely to occur in the strata near the surface, and in which geodetic observations take place, than in the upper regions of the atmosphere. Where long lines pass very close to the Earth's surface, or to intervening plateaus or mountain ranges, considerable discordances may be expected. It must be remembered, however, that conditions such as these, which frequently occur in practical geodesy, must upset any theory. It cannot, therefore, be expected that any theory of terrestrial refraction will yield results so accurate as the Besselian theory of celestial refraction. Still, much better results must follow from expressions based on acknowledged principles rather than blind hypotheses.

For a full account of the previous treatment of the subject, the reader may consult the following references. For drawing his attention to the last publication on this list, the writer would desire to acknowledge his indebtedness to Major E. H. Hills, C.M.G.

Yvon-Villarceau.—*Recherches Théorétiques sur les Réfractions Terrestres*, Bureau des Longitudes, Dec. 12 and 19, 1860.

E. Pucci.—*Fondamenti di Geodesia*, vol. i., Milan, 1883.

Dr. W. Jordan.—*Astronomische Nachrichten*, No. 88, pp. 99–107, 1876.

Dr. W. Jordan.—*Handbuch der Vermessungskunde*, 5th ed., Stuttgart, 1904.

Carl M. von Bauernfeind.—*Denkschriften der k. bay. Akademie der Wissenschaften*, xvi., i. pp. 519–567, 1888.

Carl M. von Bauernfeind.—*Elemente der Vermessungskunde*, 7th ed., Stuttgart, 1890.

Dr. F. R. Helmert.—*Theorieen der Höheren Geodäsie*, vol. ii. chap. 8, Leipzig, 1884.

Lieut. A. Luria.—*Rivista di Artiglieria e Genio*, vol. i., Rome, 1907.

Comparisons of the places of Mars calculated from Newcomb's Tables, with the places calculated from Le Verrier's Tables, near the times of Opposition in 1907 *and* 1909. By A. M. W. Downing, D.Sc., F.R.S.

These comparisons have been made by reducing the quantities given in the *Nautical Almanac* from Greenwich noon to Paris noon at convenient intervals, and then finding the differences between the reduced quantities and the corresponding quantities in the *Connaissance des Temps*.

It will be noticed that at these oppositions, when the planet is nearly at its least possible distance from the Earth, the differences in the heliocentric places derived from the two sets of Tables are much magnified when the transformation to geocentric places is effected. Also it must be remembered that different Tables of the Sun (Newcomb's and Le Verrier's respectively) are employed in making the transformation in the two cases. It will be remarked, however, that the difference in heliocentric longitude, which vanishes in 1907 September, is as much as 4″ in 1909 September. It appears desirable, at the present time, to draw attention to this discordance, as well as to the corresponding discordances in the geocentric places, which amount to comparatively large quantities at the epochs considered.

Mars 1907—*Corrections to Le Verrier's Tables.*

Day 1907.	R.A. Time.	R.A. Arc.	Decl.
	s	″	″
May 26	+·16	+2·2	−0·8
June 3	·17	2·3	0·8
11	·23	3·1	0·6
19	·28	3·8	0·8
27	·28	3·8	1·2
July 5	·29	3·9	1·4
13	·28	3·7	1·2
21	·25	3·4	1·8
29	·19	2·5	1·7
Aug. 6	·14	1·9	1·6
14	+·13	+1·7	−1·1

On July 5 (near the time of Opposition):—

the correction to Le Verrier's heliocentric longitude of Mars is + 0″·7;

the correction to Le Verrier's longitude of the Sun is − 0″·5;

the distance of Mars from the Earth is 0·41.

Mars 1909—*Corrections to Le Verrier's Tables.*

Day 1909.		R.A. Time. s	R.A. Arc. ″	Decl. ″
Aug.	14	−·46	−6·9	−4·5
	22	50	7·5	4·8
	30	·58	8·7	5·1
Sept.	7	·66	9·9	5·8
	15	·70	10·5	5·8
	23	·70	10·5	5·5
Oct.	1	·72	10·8	5·6
	9	·70	10·5	4·9
	17	·60	9·0	4·2
	25	·58	8·7	4·3
Nov.	2	−·52	−7·8	−4·0

On September 23 (near the time of Opposition) :—

the correction to Le Verrier's heliocentric longitude of Mars is − 4″·1 ;

the correction to Le Verrier's longitude of the Sun is − 0″·9 ;

the distance of Mars from the Earth is 0·39.

1907 *September* 23.

Errata in Mr. Innes's Paper on the Computation of Secular Perturbations,—M. N., vol. lxvii., No. 7.

To distinguish k_1 on pp. 431, 438, 439, lines 19 and 20, and 443, from the k_1 of the cubic on p. 432, etc., write k'.

p. 431, table, and p. 432, line 2,

for $\frac{a}{r_0}$ *read* $\frac{a}{r}$

p. 440. In

$$\left(3\chi - \tfrac{1}{4}g_2 r_0\right)\frac{F_B}{\lambda^{\frac{7}{4}}} + \frac{F_A}{\lambda^{\frac{5}{4}}}$$

interchange suffices $_A$ and $_B$, and then

for $\frac{F_B}{\lambda^{\frac{5}{4}}}$ *read* $\phi\frac{F_B}{\lambda^{\frac{5}{4}}}$

p. 442 and p. 443. Interchange the numerical values of the F functions.

For a numerical application of the formulæ see Mr. C. J. Merfield's paper to be published shortly in the *Astr. Nachr.*

Corrections to Prof. E. E. Barnard's Paper on the "Owl" Nebula,—M. N., vol. lxvii., No. 8.

On page 549, for nucleus (1) and (4) the distance measure on 1902 Feb. 24 should be 157″·68 instead of 158″·68. The mean for the observation for these stars for 1902 is correctly printed.

For nucleus (1) and (5) the error is in the mean; it should be 181″·07 instead of 181″·11.

On page 543, line 25, *for* 1 : 32, *read* 1 : 3·2; and on line 26, *for* 32 times, *read* 3·2 times.

LIST OF ADDITIONS

TO THE LIBRARY

OF THE SOCIETY

JUNE 1906 TO JUNE 1907.

An asterisk (*) indicates that the work is an excerpt.

Abbadia, Observatoire:

Observations faites au cercle méridien en 1902–4. Tome 3, 4. Publiées par A. Verschaffel.
(*Observatory.*) 4to. Hendaye, 1905–1906

Acta Mathematica. Zeitschrift, herausgegeben von Mittag-Leffler. Band 30, pt. 3, 4.
(*Turnor and Horrox Fund.*) 4to. Stockholm, 1906

Adelaide, Government Observatory:

Meteorological Observations made at the Adelaide Observatory and other places in South Australia and the Northern Territory during the years 1902–1904, under the direction of Sir Charles Todd.
(*Observatory.*) fol. Adelaide, 1905–1906

Algiers, Observatoire:

—— : Carte photographique du Ciel. Zone $-1°$, $+1°$, $+3°$, $+4°$. (56 charts.)
(*French Minister of Public Instruction.*)

—— : Tables et cartes d'Occultations: Théorie et applications. Par Charles Trépied.
(*Observatory.*) 4to. Paris, 1906

Ambronn (J. and R.):

Sternverzeichnis, enthaltend alle Sterne bis zur 6·5ten Grösse für das Jahr 1900·0, bearbeitet auf Grund der genauen Kataloge . . . Mit einem erläuternden Vorwort versehen, und herausgegeben von Dr. L. Ambronn.
(*Turnor and Horrox Fund.*) 4to. Berlin, 1907

American Academy of Arts and Sciences: *see* **Boston.**

American Journal of Mathematics. Edited by T. Craig and S. Newcomb. Published under the auspices of the Johns Hopkins University. Vol. 28, No. 2—Vol. 29, No. 2.
(*Editors.*) 4to. Baltimore, 1906–1907

American Journal of Science. Editor E. S. Dana [and others]. Fourth series, Vol. 21–23 (No. 126–138).
(*Editors.*) 8vo. New Haven, 1906–1907

Amsterdam. Koninklijke Akademie van Wetenschappen:
——: Verhandelingen (Eerste Sectie), Deel 9, pt. 1–3.
(*Academy.*) 8vo. Amsterdam, 1905–1906
——: Verslagen van de gewone Vergaderingen der Wis- en Natuurkundige Afdeeling, 1904–1906. Deel 13, 14.
(*Academy.*) 8vo. Amsterdam, 1904–1906
——: Proceedings of the section of Sciences, Vol. 7: Vol. 8 pt. 1 and 2.
(*Academy.*) 8vo. Amsterdam, 1904–1906
——: Jaarboek, 1904–1905.
(*Academy.*) 8vo. Amsterdam, 1905–1906

Arcetri, Reale Osservatorio:
Pubblicazioni del R. Istituto di studi superiori pratici e di perfezionamento, fasc. 21, 22.
(*Observatory.*) 4to. Firenze, 1906
21. A. Abetti. Osservazioni astronomische fatte . . . 1905.
22. B. Viaro. L'Asteroide (345) Tercidina.

Astronomical Journal. Founded by B. A. Gould [edited by S. C. Chandler]. Vol. 25 (No. 587–594).
(*Editor.*) 4to. Boston, 1906–1907

Astronomische Mittheilungen. Gegründet von Rudolf Wolf: herausgegeben von A. Wolfer. No. 97.
(*Editor.*) 8vo. Zürich, 1906

Astronomische Nachrichten. Begründet von H. C. Schumacher: herausgegeben von H. Kreutz. Band 171–174 (No. 4096–4182).
(*Editor.*) 4to. Kiel, 1906–1907
——: Astronomische Abhandlungen, als Ergänzungshefte zu den Astronomischen Nachrichten, herausgegeben von H. Kreutz. No. 12.
(*Editor.*) 4to. Kiel, 1907
Untersuchungen über die Bewegung des Planeten (13) Egeria. J. H. Hoelling.

Astronomische Rundschau Herausgegeben von der Manora-Sternwarte in Lussinpiccolo (Oesterreich), unter der verantwortlichen Redaction von Leo Brenner. Band 8, 9 (Heft 77–86).
(*Turnor and Horrox Fund.*) 8vo. Altenburg, 1906–1907

Astronomischer Jahresbericht. Begründet von W. F. Wislicenus: mit Unterstützung der Astronomischen Gesellschaft herausgegeben von A. Berberich. Band 7, enthaltend die Literatur des Jahres 1905.
(*Editor.*) 8vo. Berlin, 1906

Astrophysical Journal (the). An International Review of spectroscopy and astronomical physics. Edited by G. E. Hale [and others]. Vol. 24, No. 1—Vol. 25, No. 4.
(*Editors.*) 8vo. Chicago, 1906–1907

Athenæum (the). Journal of English and foreign literature, science, the fine arts, music, and the drama, 1906–1907 (No. 4102–4155).
(*Editor.*) 4to. London, 1906–1907

Athens, Observatoire National:
Annales . . . publiées par Démétrius Eginitis. Tome 4.
(*Observatory.*) 4to. Athènes, 1906

Ball (Leo de):
——: Refraktionstafeln. [Introduction in German and French.]
(*Turnor and Horrox Fund.*) 4to. Leipzig, 1906
——: *Die Radau'sche Theorie der Refraktion.
(*Von Kuffner Observatory.*) 8vo. Wien, 1906

Barnard (Edward Emerson):
——: *On the vacant regions of the sky.
(*Author.*) 8vo. Northfield, Minn., 1906
——: *Photographic observations of Giacobini's comet.
(*Author.*) 8vo. Chicago, 1906
——: *On a nebulous groundwork in the Constellation Taurus.
(*Author.*) 8vo. Chicago, 1907

Barton (Samuel Goodwin):
Secular Perturbations arising from the action of Saturn upon Mars: an application of the method of Arndt. [University Thesis.]
(*Pennsylvania University.*) 8vo. Philadelphia, 1906

Basel, Naturforschende Gesellschaft:
Verhandlungen; Band 18, Heft 3.
(*Society.*) 8vo. Basel, 1906

Basel, Universitat:
Jahresverzeichniss der schweizerischen Universitätsschriften, 1905–1906.
(*University.*) 8vo. Basel, 1906

Bashforth (Francis):
Ballistic experiments from 1864 to 1880.
(*Author.*) 8vo. Cambridge, 1907

Batavia, Koninklijke Natuurkundige Vereeniging in Nederlandsch-Indië:
Natuurkundig Tijdschrift voor Nederlandsch-Indië. Deel 65 (Serie 10, Deel 9).
(*Society.*) 8vo. Batavia, 1905

Batavia, Royal Magnetical and Meteorological Observatory :

—— : Observations . . . published by order of the Government of Netherlands India. Vol. 27, 1904.
(*Observatory.*) 4to. Batavia, 1906

—— : Regenwaarnemingen in Nederlandsch-Indië, Jaargang 27, 1905.
(*Observatory.*) 8vo. Batavia, 1906

Baxandall (F. E.) :

*On the enhanced lines of Iron, Titanium, and Nickel.
(*Author.*) 8vo. Chicago, 1905

Belfast Natural History and Philosophical Society :

Report and Proceedings . . . for the session 1905–6.
(*Society.*) 8vo. Belfast, 1906

Bentabol y Ureta (Horacio) :

Cuestiones Astronómicas.
(*Author.*) 8vo. Madrid, 1906

Berlin, Deutsche physikalische Gesellschaft :

—— : Die Fortschritte der Physik im Jahre 1905. Jahrgang 61, dritte Abtheilung, enthaltend kosmische Physik, redigirt von Richard Assmann.
(*Society.*) 8vo. Braunschweig, 1906

—— : Die Fortschritte der Physik im Jahre 1906–7. Halbmonatliches Literaturverzeichniss. Jahrg. 5, No. 11–24; Jahrg. 6, No. 1–10.
(*Society.*) 8vo. Braunschweig, 1906–1907

Berlin. Königlich Astronomisches Rechen-Institut :

—— : Berliner Astronomisches Jahrbuch für 1908; mit Angaben für die Oppositionen der Planeten (1)–(553) für 1906, herausgegeben . . . unter Leitung von J. Bauschinger.
(*Institute.*) 8vo. Berlin, 1906

—— : Veröffentlichungen. No. 30–32.
(*Institute.*) 4to. Berlin, 1906–1907

30. J. Bauschinger [etc.]. Genäherte Oppositions-Ephemeriden von 29 kleinen Planeten, 1906–7.
31. J. Bauschinger [etc.]. Genäherte Oppositions-Ephemeriden von 38 kleinen Planeten, 1907.
32. J. Bauschinger [etc.]. Genäherte Oppositions-Ephemeriden von 32 kleinen Planeten, 1907.

Berlin, Königlich Preussische Akademie der Wissenschaften :

—— : Abhandlungen, 1906.
(*Academy.*) 4to. Berlin, 1906

—— : Sitzungsberichte, 1906, No. 23–53; 1907, No. 1–22.
(*Academy.*) 8vo. Berlin, 1906–1907

Berlin, Vereinigung von Freunden der Astronomie und kosmischen Physik :

Mittheilungen, Jahrgang 16, Heft 5—Jahrgang 17, Heft 4.
(*Turnor and Horrox Fund.*) 8vo. Berlin, 1906–1907

Besançon, Observatoire National Astronomique, Chronométrique et Météorologique :

—— : Bulletin Astronomique, 1–11.
(*Observatory.*) 4to. Besançon, 1886–1906

—— : Bulletin Chronométrique, 3–5, 7–9, 11, 13, 15–17.
(*Observatory.*) 4to. Besançon, 1891–1906

—— : Bulletin Météorologique, 1–14, 16–18.
(*Observatory.*) 4to. Besançon, 1890–1902

Birmingham and Midland Institute Scientific Society :

Records of meteorological observations taken at the Observatory, Edgbaston, 1906, by Alfred Cresswell.
(*Society.*) 8vo. Birmingham, 1907

Birmingham Natural History and Philosophical Society :

Proceedings, Vol. 12, No. 1.
(*Society.*) 8vo. Birmingham, 1907

Black (F. A.) :

The Precession of the Equinoxes ; Is the accepted explanation correct ?
(*Author.*) 8vo. Inverness, 1907

Bologna, Osservatorio della R. Università :

—— : *Osservazioni meteorologiche . . . 1905.
(*Observatory.*) 4to. Bologna, 1906

—— : *Esame di una livella difettosa, e metodo per correggerne le indicazioni. Nota de M. Rajna.
(*Observatory.*) 4to. Bologna, 1906

—— : *Sopre le dimostrazioni della formula del Cagnoli relativa alla durata minima del crepuscolo. Nota di Michele Rajna.
(*Observatory.*) 4to. Bologna, 1907

Bologna. Reale Accademia delle Scienze dell' Istituto :

—— : Memorie, Sezione delle scienze fisiche e matematiche, Serie 6, Tomo 2.
(*Academy.*) 4to. Bologna, 1906

—— : Rendiconto della sessione 1904–1905. Nuova Serie, Vol. 9.
(*Academy.*) 8vo. Bologna, 1906

Bombay Branch of the Royal Asiatic Society :

Journal, Vol. 22, No. 61.
(*Society.*) 8vo. Bombay, 1906

Bombay, Government Observatory :

Report . . . 1906.
(*Observatory.*) fol. Bombay, 1907

Bordeaux, Commission Météorologique de la Gironde :

Observations pluviométriques et thermométriques faites . . . . de Juin 1905 à Mai 1906. Note de F. Courty.
(*Bordeaux Observatory.*) 8vo. Bordeaux, 1906

Bordeaux Observatoire :

—— : Annales . . . publiées par G. Rayet, Tome 12.
(*Observatory.*) 4to. Paris et Bordeaux, 1906

Bordeaux Observatoire—*continued*:
—— : Carte photographique du Ciel. Zone + 16° (11 charts).
(*French Minister of Public Instruction.*)

Bordeaux, Société des Sciences Physiques et Naturelles :
—— : Procés-verbaux des séances, année 1904–5 ; 1905–6.
(*Society.*) 8vo. Paris et Bordeaux, 1905–1906
—— : Table générale des matières des publications de la Société de 1850 à 1900.
(*Society.*) 8vo. Bordeaux, 1905
—— : Cinquantenaire de la Société, 15–16 Janvier 1906.
(*Society.*) 8vo. Bordeaux, 1906

Boston, American Academy of Arts and Sciences :
—— : Memoirs : Vol. 13, No. 4.
(*Academy.*) 4to. Cambridge, Mass., 1906
—— : Proceedings. Vol. 41, No. 30—Vol 42, No. 26.
(*Academy.*) 8vo. Boston, Mass., 1906–1907

Bramsen (William) :
Japanese chronological tables, showing the date, according to the Julian or Gregorian Calendar, of the first day of each Japanese month, from Tai-kwa 1st year to Mei-ji 6th year (645 A.D. to 1873 A.D.). With an introductory essay on Japanese chronology and calendars.
(*E. B. Knobel.*) obl. 4to. Tokio, 1880

Brisbane, Royal Geographical Society of Australasia :
Queensland Geographical Journal (New Series), session 21, 1905–1906, Vol. 21.
(*Society.*) 8vo. Brisbane, 1906

British Association for the Advancement of Science :
Reports of the 75th and 76th meetings, 1905 and 1906.
(*Association.*) 8vo. London, 1906–1907

British Bechuanaland and German S.W. Africa :
Report on the boundary Survey . . . executed by Lieut.-Col. Laffan . . Lieut. Wettstein and Oberlieutenant Doering . . under the direction of Sir David Gill. [English and German.]
(*Royal Observatory, Cape of Good Hope.*) fol. Berlin, 1906

Brussels, Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique :
—— : Bulletin de la classe des sciences ; 1906, No. 3–12 ; 1907, No. 1.
(*Academy.*) 8vo. Bruxelles, 1906–1907
—— : Classe des Sciences : Mémoires (Collection in 8vo). Série 2. Tome 1, fasc. 4–8.
(*Academy.*) 8vo. Bruxelles, 1906
—— : Annuaire, année 73.
(*Academy.*) 8vo. Bruxelles, 1907

Brussels, Société Belge d'Astronomie:
Bulletin . . . Comptes rendus des séances mensuelles de la Société, et revue des sciences d'observation: astronomie, météorologie, géodésie et physique du globe. Année 11, No. 6–11; Année 12, No. 1–5.
(*Society.*) 8vo. Bruxelles, 1906–1907

Budapest, Königl. Ungarische Reichsanstalt für Meteorologie und Erdmagnetismus:
—— : Bericht über die Thätigkeit der Kgl. ung. Reichsanstalt . . . und des Central-Observatoriums in O-Gyalla im Jahre 1905.
(*Institute.*) 8vo. Budapest, 1906
—— : Jahrbücher. Band 33, Theil 4; Band 34, Theil 1, 3.
(*Institute.*) 4to. Budapest, 1906
—— : Namen- und Sachregister der Bibliothek.
(*Institute.*) 8vo. Budapest, 1906

Budapest, Magyar Tudományos Akadémia:
—— : Almanach, 1906.
(*Academy.*) 8vo. Budapest, 1906
—— : Mathematikai és természettudományi Értesitö. Kotet 23, 3–5; 24, 1–2.
(*Academy.*) 8vo. Budapest, 1905–1906
—— : Mathematikai és természettudományi Közlemények. Kotet 28, 4.
(*Academy.*) 8vo. Budapest, 1906
—— : Rapport sur les travaux de l'Académie hongroise des Sciences en 1905, par G. Heinrich.
(*Academy.*) 8vo. Budapest, 1906

Bulletin Astronomique. Fondé en 1884 par E. Mouchez et F. Tisserand. Publié par l'Observatoire de Paris. Tome 23, No. 6—Tome 24, No. 5.
(*Turnor and Horrox Fund.*) 8vo. Paris, 1906–1907

Bulletin des Sciences Mathématiques. Rédigé par G. Darboux et J. Tannery. Série 2. Tome 30, No. 5—Tome 31, No. 5.
(*Editors.*) 8vo. Paris, 1906–1907

Calcutta, Asiatic Society of Bengal:
—— : Journal and Proceedings, Vol. 2, No. 4–9.
(*Society.*) 8vo. Calcutta, 1906
—— : Memoirs, Vol. 1, No. 10–19.
(*Society.*) 4to. Calcutta, 1906

Cambridge Observatory:
Annual Report of the Observatory Syndicate, 1905–6.
(*Observatory.*) 4to. Cambridge, 1906

Cambridge Philosophical Society:
—— : Proceedings, Vol. 13, pt. 6; Vol. 14, pt. 1.
(*Society.*) 8vo. Cambridge, 1906–1907
—— : Transactions, Vol. 20, pt. 9–12.
(*Society.*) 8vo. Cambridge, 1906–1907

Canada, Geological Survey:
Annual Report (new series), 1901–1903. Vol. 14, 15.
(*Survey Office.*) 8vo. Ottawa, 1905–1906

Canada, Royal Society:
Proceedings and Transactions. Second series. Vol. 11, 1905.
(*Society.*) 8vo. Ottawa [Montreal], 1906

Cape of Good Hope, Royal Observatory:
—— : Annals, Vol. 10, pt. 2; Vol. 12, pt. 2, 3.
(*Observatory.*) 4to. Edinburgh, 1906
Vol. 10, pt. 2. J. Lunt. Spectra of Silica, Fluorine and Oxygen.
,, 12, ,, 2. B. Cookson. Determination of the mass of Jupiter and orbits of the Satellites.
,, 12, ,, 3. W. de Sitter. Determination of inclination and nodes of the orbits of Jupiter's Satellites.
—— : Catalogue of stars for the equinox 1900·0, from observations made . . . during the years 1900–1904, under the direction of Sir David Gill.
(*Observatory.*) 4to. Edinburgh, 1906
—— : A Catalogue of 8560 astrographic standard stars, between declinations -40° and -52° for the equinox 1900, from observations made . . . during the years 1896–90, under the direction of Sir David Gill.
(*Observatory.*) 4to. London, 1906
—— : Results of meridian observations of stars made . . . in the years 1900–1904, under the direction of Sir David Gill.
(*Observatory.*) 4to. Edinburgh, 1906
—— : Independent day numbers for the years 1908, 1909.
(*Observatory.*) 8vo. London, 1905–1906
—— : Report of H.M. Astronomer . . . for the year 1905.
(*Observatory.*) 4to. London, 1906

Cape Town, South African Philosophical Society:
Transactions. Vol. 16, pt. 3; Vol. 17, pt. 1.
(*Society.*) 8vo. Cape Town, 1906–1907

Cardiff, Astronomical Society of Wales:
The Cambrian Natural Observer. New series. Vol. 8 (1905).
(*Society.*) 16mo. Cardiff, 1906

Carnoy (Henry):
Ernest Lebon. (Dictionnaire Biographique International.)
(*E. Lebon.*) 8vo. Paris.

Catania, Reale Osservatorio:
—— : * Sulle protuberanze solari osservate . . . nell' anno 1905. A. Mascari.
(*Observatory.*) 4to. Catania, 1906
—— : * Eclisse parziale di Sole del 30 Agosto 1905.
(*Observatory.*) 4to. Catania, 1906

Catania, Società degli Spettroscopisti Italiani:
Memorie . . . raccolte e pubblicate per cura del Prof. A. Riccò. Vol. 35, No. 6—Vol. 36, No. 5.
(*Society.*) 4to. Catania, 1905–1906

Chatham, Royal Engineers' Institute:
The Royal Engineers' Journal, Vol. 4, 5.
(*Institute.*) 8vo. Chatham, 1906–1907

Chree (Charles):
*Experiments on the effects of change of barometric pressure on the rates of watches, and their discussion.
(*Nat. Phys. Laboratory.*) 8vo. London, 1906

Ciel et Terre. Revue populaire d'astronomie, de météorologie et de physique du globe. Année 27, No. 8—Année 28, No. 7.
(*Turnor and Horrox Fund.*) 8vo. Bruxelles, 1906–1907

Clancey (John Charles):
Survey Manual for Land Records officers.
(*Author.*) 8vo. Rangoon, 1906

Colorado College Observatory:
Semi-annual Bulletin, Nov. 1905, June 1906, Jan. 1907.
(*Observatory.*) 8vo. Colorado Springs, 1906–7

Copenhagen, Kongelige Danske Videnskabernes Selskab:
——: Oversigt over det K. Danske Videnskabernes Selskabs Forhandlinger. 1906, No. 2–6: 1907, No. 1.
(*Society.*) 8vo. Kjöbenhavn, 1906–1907
——: Skrifter, naturvidensk. og mathematisk Afd.: 7te Række, Bd. 1, No. 5, 6; Bd. 2, No. 5, 6; Bd. 3, No. 1.
(*Society.*) 4to. Kjöbenhavn, 1905

Cortie (Rev. A. L.):
*The total Solar Eclipse of 1905. Report of the Stonyhurst College expedition to Vinaroz, Spain.
(*Author.*) 4to. Dublin, 1906

Cotes (Roger):
Hydrostatical and pneumatical lectures . . . with notes by Robert Smith.
(*T. Colby.*) 8vo. London, 1738

Cracow, Académie des Sciences:
——: Bulletin International: Comptes rendus des séances, 1905, No. 8–10; 1906, No. 1–10; 1907, No. 1–3.
(*Academy.*) 8vo. Cracovie, 1905–1907
——: Catalogue of Polish scientific literature. Tom. 5, No. 3, 4; Tom. 6, No. 1, 2.
(*Academy.*) 8vo. Kraków, 1905–1906

Craig (Martha):
First Principles. A manifesto of the vortex theory of creation.
(*Author.*) 8vo. London, *n.d.*

Dijon, Académie des Sciences, Arts et Belles-lettres:
Mémoires, 4me série, Tome 10 (1905–6).
(*Academy.*) 8vo. Dijon, 1906

Donitch (N.):
*Observations de l'éclipse totale du Soleil du 29–30 août 1905.
(*Author.*) 4to. St Pétersbourg, 1906

Drescher (Adolf):
Kosmisches Leben im Werden und Vergehen (Spiralnebel und Sternhaufen).
(*Author.*) 8vo. Mainz, 1906

Dreyer (John L. E.):
History of the planetary systems from Thales to Kepler.
(*W. H. Wesley.*) 8vo. Cambridge, 1906

Dublin, Royal Irish Academy:
——: Proceedings, third series (Section A), Vol. 26, No. 1, 2; Vol. 27, No. 1, 2.
(*Academy.*) 8vo. Dublin, 1906–1907
——: Transactions (Section A), Vol. 33, pt. 1.
(*Academy.*) 4to. Dublin, 1906

Dublin, Royal Society:
——: Scientific Proceedings. New series. Vol. 11, No. 12–15.
(*Society.*) 8vo. Dublin, 1906–1907
——: Scientific Transactions. Series II. Vol. 9, pt. 4, 5.
(*Society.*) 4to. Dublin, 1907

Edinburgh, Royal Observatory:
——: Annals, Vol. 1, 2.
(*Observatory.*) 4to. Glasgow, 1902–6
Vol. 1. L. Becker, Observations of Nebulæ; L. Becker, Positions of Stars near the north pole; J. Halm, Theory of the Sun; J. G. Lohse, New double image micrometer.
,, 2. J. Halm, New reduction of Henderson's Catalogue.
——: Seventeenth annual report of the Astronomer Royal for Scotland, 1906–7.
(*Observatory.*) 8vo. Glasgow, 1907

Edinburgh, Royal Society:
——: Proceedings. Vol. 26, pt. 3–6; Vol. 27, pt. 1, 2.
(*Society.*) 8vo. Edinburgh, 1906–1907
——: Transactions, Vol. 41, pt. 3; Vol. 45, pt. 1.
(*Society.*) 4to. Edinburgh, 1906

Egypt, Survey Department:
——: Meteorological Report for the year 1904, pt. 1, 2.
(*Department.*) 4to. Cairo, 1906
——: Meteorological Observations (at various stations). 1905 November.
(*Department.*) fol. 1905

Enebo (Sigurd):
*Beobachtungen veränderlicher Sterne angestellt auf Dombaas (Norwegen).
(*Author.*) 8vo. Kristiania, 1906

English Mechanic (the) and World of Science. Vol. 83–85 (No. 2151–2203).
(*Editor.*) fol. London, 1906–1907

Farman (Maurice):
Mesures d'Étoiles Doubles faites à l'Observatoire de Chevreuse de 1904 à 1906.
(*Author.*) 4to. Paris, 1907

Franz (Julius):
*Die Vertheilung der Meere auf der Mondoberfläche.
(*Author.*) 8vo. Berlin, 1906

Frič (Joseph Jan) and Fr. Nušl:
*Deuxième étude sur l'appareil circumzénithal.
(*J. J. Frič.*) 8vo. Prague, 1906

Galilei (Galileo):
Opere . . . Edizione Nazionale, sotto gli auspicii di Sua Maestà il Re d'Italia. Vol. 17, 18.
(*Italian Government.*) 4to. Firenze, 1906

Gauss (Carl Friedrich):
Werke . . . herausgegeben von der königlichen Gesellschaft der Wissenschaften zu Göttingen. Band 7. [New edition, edited by M. Brendel.]
(*Editor.*) 4to. Leipzig, 1906

Gautier (Raoul):
Rapport sur le Concours de réglage de chronomètres, 1906.
(*Author.*) 8vo. Genève, 1907

Gehrcke (E.):
Die Anwendung der Interferenzen in der Spektroskopie und Metrologie.
(*Turnor and Horrox Fund.*) 8vo. Braunschweig, 1906

Geneva, Observatoire:
—— : *Résumé météorologique . . . pour Genève et le Grand Saint-Bernard, par R. Gautier, 1905.
(*Observatory.*) 8vo. Genève, 1906
—— : *Observations météorologiques faites aux fortifications de Saint-Maurice pendant l'année 1904–5. Résumé par R. Gautier.
(*Author.*) 8vo. Genève, 1906

Geneva, Société de physique et d'histoire naturelle:
Mémoires, Tome 35, fasc. 2.
(*Society.*) 4to. Genève, 1906

Gill (Sir David):
*On the origin and progress of geodetic Survey in South Africa, and of the African Arc of Meridian.
(*Author.*) 8vo.

Ginzel (Friedrich Karl) :

Handbuch der mathematischen und technischen Chronologie : das Zeitrechnungswesen der Völker. Band 1.
(*Turnor and Horrox Fund.*) 8vo. Leipzig, 1906
Zeitrechnung der Babylonier, Ägypter, Mohammedaner, Perser, Inder, Südostasiaten, Chinesen, Japaner, und Centralamerikaner.

Goodwin (H. B.) :

*Prime Vertical reduction tables.
(*Author.*) 8vo. Glasgow, 1906

Gore (John Ellard) :

The Stellar Heavens : an introduction to the study of the stars and nebulæ.
(*W. H. Wesley.*) 8vo. London, 1903

Göttingen, Königliche Gesellschaft der Wissenschaften :

Nachrichten, mathematisch-physikalische Klasse. 1906, Heft 1–5.
(*Society.*) 8vo. Göttingen, 1906

Göttingen, Königliche Sternwarte :

Astronomische Mittheilungen, Theil 12.
(*Observatory.*) 4to. Göttingen, 1906
Br. Meyermann. Vermessung der Umgebung des Orionnebels.

Granada, Observatorio Astronomico, Geodinamico y Meteorológico :

—— : Boletin Mensual. Año 4 (1906), No. 2–12 ; Año 5 (1907), No. 1–3.
(*Observatory.*) fol. Granada, 1906–1907

—— : Eclipse total de Sol del 30 de Agosto de 1905 : observaciones hechas en Carrión de los Condes (Palencia). Fasc. 1–3.
(*Observatory.*) 8vo. Granada, 1907

Greenwich, Royal Observatory :

—— : Astronomical and magnetical and meteorological observations made . . . 1904 under the direction of W. H. M. Christie.
(*Observatory.*) 4to. London, 1906

—— : Appendices :
Results of Astronomical Observations, 1904.
Results of Magnetical and Meteorological Observations, 1904.
Results of Photoheliographic Observations, 1904.
Meridian Zenith distances of γ Draconis . . . . 1886–1899.
Report of the Astronomer Royal to the Board of Visitors, 1906.
(*Observatory.*) 4to. London

—— : Astrographic Chart. Zone $+68°$ to $+74°$ (216 charts).
(*Observatory.*)

—— : Reduction of Greenwich meteorological observations, Part 4. Temperature of the air as determined from the observations and records of the fifteen years 1891–1905 . . . . Collected and discussed under the direction of W. H. M. Christie.
(*Observatory.*) 4to. London, 1906

Gruey (Louis Jules):
—— : Erreurs de division des cercles de la lunette méridienne.
(*Author.*) 4to. Besançon *n.d.*
—— : Sur un problème de gnomonique.
(*Author.*) 4to. Besançon, *n.d.*

Guillemin (A.):
Tableaux logarithmiques A et B equivalent à des tables de logarithmes à 6 et à 9 décimales, et notice explicative donnant la théorie et le mode d'emploi des tableaux.
(*Turnor and Horrox Fund.*) 8vo. Paris, 1906

Hagen (J. G.):
Atlas stellarum variabilium. Series quarta, eas stellas variabiles complectens, quarum et declinationes et magnitudines inter limites chartarum Bonnensium continentur.
(*Turnor and Horrox Fund.*) 4to. Berolini, 1907

Hadden (David E.):
*Review of solar observations for the years 1904, 1905, at Alta, Iowa.
(*Author.*) 8vo. Northfield, Minn., 1906

[Hadley (John)]:
A description of a new instrument for taking the latitude or other altitudes at sea.
(*T. Colby.*) 8vo. London, 1738

Halifax, Nova Scotian Institute of Science:
Proceedings and Transactions. Vol. 11, pt. 2. (1903–4).
(*Institute.*) 8vo. Halifax, 1906

Hall (Asaph):
*Biographical memoir of John Rogers, 1812–1882.
(*Author.*) 8vo, Washington, D.C., 1906

Hall (Maxwell):
—— : *A method of predicting the movement of tropical cyclones.
(*Author.*) 4to. 1906
—— : *The zodiacal light.
(*Author.*) 4to. 1906

Halle, Kaiserliche Leopoldinisch Carolinische Akademie der Naturforscher:
—— : Abhandlungen (Nova Acta). Band 85, 86.
(*Academy.*) 4to. Halle, 1906
—— : Leopoldina . . . . herausgegeben von K. von Fritsch. Heft 42. Jahrgang 1906.
(*Academy.*) 4to. Halle, 1906

Hartwig (Ernst):
*Ephemeriden veränderlicher Sterne für 1907.
(*Author.*) 8vo. Leipzig, 1906

Harvard College Astronomical Observatory:

——: Annals, Vol. 39, pt. 2; 52, pt. 1; 55, pt. 2; 58, pt. 2; 60, No. 1–3.
(*Observatory.*) 4to. Cambridge, Mass., 1906–1907

Vol. 39, pt. 2. S. I. Bailey. Peruvian Meteorology.
,, 52, ,, 1. Eclipses of Jupiter's Satellites, 1878–1903.
,, 52, ,, 2. Annie J. Cannon. Second Catalogue of Variables.
,, 58, ,, 2. A. L. Rotch. Blue Hill Meteorological Observations, 1903–4.
,, 60, No. 1. Early observations of the 6th Satellite of Jupiter.
,, ,, ,, 2. A. Searle. Geometrical methods in the theory of combining observations.
,, ,, ,, 3. Positions of Phœbe.

——: Circular, No. 117–129.
(*Observatory.*) 4to. Cambridge, Mass., 1906–1907

——: Sixty-first annual report of the Director . . . 1906. By E. C. Pickering.
(*Observatory.*) 8vo. Cambridge, Mass., 1906

Heath (Walter):

Occultation residuals.
(*Author.*) 8vo. London, 1907

Heidelberg, Grossherzogliche Sternwarte (Astrometrisches Institut):

——: Mittheilungen . . . herausgegeben von W. Valentiner. No. 7–9.
(*Observatory.*) 4to. Karlsruhe, 1906

No. 7. Jahresbericht, 1905.
8. A. von Brunn. Die generelle Entwicklung der Störungsfunktion.
9. W. Valentiner. Bestimmung der Längendifferenz Heidelberg—Karlsruhe.

——: Veröffentlichungen . . . herausgegeben von W. Valentiner. Band 4.
(*Observatory.*) 4to. Karlsruhe, 1906

E. Jost. Untersuchungen über die Parallaxen von 29 Fixsternen.

Heidelberg (Königstuhl), Astrophysikalisches Observatorium:

Publikationen . . . Band 2, No. 2–12; Band 3, No. 1. Herausgegeben von Max Wolf.
(*Observatory.*) 4to. Karlsruhe, 1904–1906

Helmert (Friedrich Robert):

*Die Grösse der Erde.
(*Author.*) 8vo. Berlin, 1906

Helsingfors, Finska Vetenskaps-Societet:

——: Acta Societatis Scientiarum Fennicæ. Tomus 32.
(*Society.*) 4to. Helsingforsiae, 1906

——: Öfversigt af Finska Vetenskaps-Societetens Förhandlinger, 47 (1904–6).
(*Society.*) 8vo. Helsingfors, 1905

——: Bidrag till kännedom af Finlands natur och folk. Häftet 63.
(*Society.*) 8vo. Helsingfors, 1905

Helsingfors, Institut Météorologique Central:
—— : Observations météorologiques . . . 1895–1896.
(*Institute.*) 4to. Helsingfors. 1906
—— : Observations météorologiques. . . . Etat des glaces et des neiges de Finlande, 1896–1897.
(*Institute.*) 4to. Helsingfors, 1907

Hill (George William):
Collected mathematical works. Vol. 4.
(*Author.*) 4to. Washington, 1907

Himmel und Erde. Illustrierte naturwissenschaftliche Monatsschrift, herausgegeben von der Gesellschaft Urania; Redacteur P. Schwahn. Jahrgang 18, Heft 9—Jahrgang 19, Heft 8.
(*Editor.*) 8vo. Berlin, 1906–1907

Hirayama (Shin):
*On the Harmonic Analysis of Sun-spot Numbers.
(*Author.*) 8vo. Tôkyô, 1906

Horological Journal (the). Vol. 48, 49 (No. 575–586).
(*Brit. Horol. Institute.*) 8vo. London, 1906–1907

India, Survey Department:
—— : General report on the operations of the Survey of India Department . . . during 1904–1905.
(*H.M. Govt. in India.*) fol. Calcutta, 1906
—— : Extracts from narrative reports of the survey of India for . . . 1903–1904.
(*H.M. Govt. in India.*) fol. Calcutta, 1905
—— : Auxiliary tables to facilitate the calculations of the Survey of India. Fourth edition . . . . by Lt.-Col. S. G. Burrard.
(*H.M. Govt. in India.*) 4to. Dehra Dun, 1906

Indian Engineering. An illustrated weekly journal, edited by Pat. Doyle. Vol. 39, No. 21—Vol. 41, No. 20.
(*Editor.*) fol. Calcutta, 1906–1907

International Catalogue of Scientific Literature:
E. (Astronomy), 5th annual issue (April 1905–March 1906).
C. (Physics), 5th annual issue (May 1905–May 1906).
(*Turnor and Horrox Fund.*) 8vo. London, 1906–1907

Kapteyn (Jacobus Cornelius):
Plan of selected areas . . . published by the Astronomical Laboratory at Groningen.
(*Author.*) 8vo. Groningen, 1906

Kasan, Imperial University:
Uchenuiya Zapiski. 1906, No. 5–12.
(*University.*) 8vo. Kasan, 1906

Klein (Hermann J.):
—— : *Kosmischer und irdischer Vulkanismus.
(*Author.*) 8vo Leipzig, 1904
—— : Neubildungen auf dem Monde.
(*Author.*) 8vo. Leipzig, 1906

Klotz (Otto):
Transpacific longitudes between Canada and Australia and New Zealand, executed during the years 1903–1904.
(*Author.*) 8vo. Ottawa, 1907

Knowledge and Illustrated Scientific News. Vol. 3, No. 20–25; Vol. 4, No. 1–6.
(*Turnor and Horrox Fund.*) 4to. London, 1906–1907

Kodaikánal and Madras Observatories:
—— : Bulletin, No. 5–8.
(*Observatory.*) 4to. Madras, 1906
—— : Annual Report of the Director for 1906.
(*Observatory.*) fol. Madras, 1907

Lebeuf (Auguste Victor):
—— : *Sur une nouvelle démonstration des Polynomes Hansen-Tisserand : Applications.
(*Author.*) 4to. Paris, 1892
—— : *Observation de Éclipse totale de Soleil du 28 mai 1900 à Elche, province d'Alicante, Espagne. Astronomie de position.
(*Author.*) 8vo. Montpellier, 1902

Lebon (Ernest):
—— : *Sur la construction d'une table de caractéristiques relatives à la base, 30,030 des facteurs premiers d'un nombre inférieur à 901,800,900.
(*Author.*) 8vo. Paris, 1906
—— : Table de caractéristiques relatives à la base 2310 des facteurs premiers d'un nombre inférieur à 30030.
(*Author.*) 8vo. Paris, 1906
—— : *Théorie et construction de tables permettant de trouver rapidement les facteurs premiers d'un nombre.
(*Author.*) 4to. Roma, 1906
—— : *Sur des systèmes des nombres permettant de trouver rapidement les facteurs premiers d'un nombre.
(*Author.*) 8vo. Lisbonne, 1906
—— : *Theory and construction of tables for the rapid determination of prime factors of a number.
(*Author.*) 8vo. New York, 1906
—— : *Sobre el número de números primos, desde 1 hasta N.
(*Author.*) 8vo. Madrid
See also Carnoy (H.) and Osmons (H. d').

Leiden, Sterrenwacht:
—— : Annalen, . . . herausgegeben von H. G. van de Sande Backhuyzen. Band 9, Heft 1.
(*Observatory.*) 4to. Haag, 1906
—— : Verslag van den Staat der Sterrenwacht te Leiden, 1904–1906.
(*Observatory.*) 8vo. Leiden, 1907

Leipzig, Astronomische Gesellschaft:
——: Vierteljahrsschrift, Jahrgang 41, Heft 2–4; Jahrgang 42, Heft 1.
(*Society.*) 8vo. Leipzig, 1906–1907
——: Catalog der Astronomischen Gesellschaft; zweite Abtheilung; Catalog der Sterne bis zur neunten Grösse zwischen 2° und 23° südlicher Declination für das Æquinoctium 1900. Stück 1.
(*Society.*) 8vo. Leipzig, 1906
Zone −2° bis −6°. Strassburg.
——: [Another copy presented by Prof. E. Becker.]

Leipzig, Fürstlich Jablonowski'sche Gesellschaft:
Jahresbericht, 1907.
(*Society.*) 8vo. Leipzig, 1907

Leipzig, Königlich Sächsische Gesellschaft der Wissenschaften:
——: Abhandlungen, mathematisch-physische Classe. Band 29, No. 5–8.
(*Society.*) 8vo. Leipzig, 1906
——: Berichte über die Verhandlungen: mathematisch-physische Classe. Band 57, Heft 5, 6; Band 58, Heft 1–8; Band 59, Heft 1.
(*Society.*) 8vo. Leipzig, 1905–1907.

Lick Observatory, University of California:
Bulletin, No. 97–114.
(*Observatory.*) 4to. 1906–1907

Lisbon, Sociedade de Geographia:
Boletim, 24 (1906), No. 7–10; 25 (1907) No. 1–4.
(*Society.*) 8vo. Lisboa, 1906–1907

Liverpool Astronomical Society:
Annual Report, 1906–1907.
(*Society.*) 8vo. Liverpool, 1907

Liverpool Observatory:
Report of the director of the observatory to the Marine Committee, and meteorological results . . . 1905
(*Observatory.*) 8vo. Liverpool, 1906

Lockyer (Sir Norman):
*Further researches on the temperature classification of stars, No. 2.
(*Solar Physics Observatory.*) 8vo. London, 1905

Lockyer (Sir Norman) and F. E. Baxandall:
*Some stars with peculiar spectra.
(*Authors.*) 8vo. London, 1906

Lockyer (William J. S.):
*Barometric variations of long duration over large areas.
(*Author.*) 8vo. London, 1906

London, British Astronomical Association:
——: Journal, Vol. 16, No. 8–10; Vol. 17, No. 1–7.
(*Association.*) 8vo. London, 1906–1907
——: Memoirs, Vol. 14, pt. 3; Vol. 15.
(*Association.*) 8vo. London, 1906
——: List of members, 1906.
(*Association.*) 8vo. London, 1906
——: The Total Solar Eclipse, 1905. Reports of observations made by Members of the British Astronomical Association of the total Solar Eclipse of 1905 August 30. Edited by F. W. Levander.
(*Association.*) 8vo. London, 1906

London, Geological Society:
——: Quarterly Journal, Vol. 62, 63 (No. 247–250).
(*Society.*) 8vo. London, 1906–1907
——: Geological literature added to the . . . Library, 1906.
(*Society.*) 8vo. London, 1907

London, Meteorological Office:
——: Hourly readings obtained from the self-recording instruments at the four Observatories under the Meteorological Council, 1904, 1905. (New Series, Vol. 5, 6).
(*The Office.*) 4to. London, 1906–1907
——: Meteorological Observations at stations of the second order for the year 1902.
(*The Office.*) 4to. London, 1907
——: Weekly weather report, Vol. 23, No. 23–52; Vol. 24, No. 1–22.
(*The Office.*) 4to. London, 1906–1907
——: First Report of the Meteorological Committee to the Lords Commissioners of His Majesty's Treasury, for the year ending 31st March 1906.
(*The Office.*) 8vo. London, 1906
——: The life history of surface air currents; a study of the surface trajectories of moving air, by W. N. Shaw and R. G. K. Lempfert.
(*The Office.*) 4to. London, 1906

London, Optical Society:
*Transactions, Session 1902–3.
(*Society.*) 8vo. London

London, Nautical Almanac and Astronomical Ephemeris for the meridian of the Royal Observatory, Greenwich. 1910
(*Lords Commissioners of Admiralty.*) 8vo. London, 1906
——: Ditto, Part 1; containing such portions as are essential for navigation, 1910
(*Lords Commissioners of Admiralty.*) 8vo. London, 1906

London, Physical Society:
Proceedings, Vol. 20, pt. 2–4.
(*Society.*) 8vo. London, 1906–1907

London, Royal Astronomical Society:
——: Memoirs, Vol. 57, Appendix 1.
4to. London, 1907
——: Monthly Notices, Vol. 67.
8vo. London, 1907

London, Royal Geographical Society:
The Geographical Journal, including the Proceedings of the Royal Geographical Society. Vol. 28, 29.
(*Society.*) 8vo. London, 1906–1907

London, Royal Institution of Great Britain:
Proceedings, 1903–1904. Vol. 18, pt. 1 (No. 99).
(*Institution.*) 8vo. London, 1906

London, Royal Meteorological Society:
——: Quarterly Journal, Vol. 32, 33 (No. 139–143).
(*Society.*) 8vo. London, 1906–1907
——: The Meteorological Record: Monthly results of observations made at the stations of the Royal Meteorological Society, with remarks on the weather . . . by W. Marriott. Vol. 25–26 (No. 99–102).
(*Society.*) 8vo. London, 1906–1907

London, Royal Photographic Society:
The Photographic Journal; including the Transactions of the Royal Photographic Society, Vol. 46, No. 6–11; Vol. 47, No. 1–5.
(*Society.*) 8vo. London, 1906–1907

London, Royal Society:
——: Philosophical Transactions, Series A, Vol. 206, 207 (No. 403–418).
(*Society.*) 4to. London, 1906–1907
——: Proceedings, Series A, Vol. 77, 78, 79 (No. 520–530).
(*Society.*) 8vo. London, 1906–1907
——: Year-book, 1907.
(*Society.*) 8vo. London, 1907

London, Royal United Service Institution:
Journal, Vol. 50, 51 (No. 340–351).
(*Institution.*) 8vo. London, 1906–1907

London, Society of Arts:
Journal, Vol. 54, 55 (No. 2794–2846).
(*Society.*) 8vo. London, 1906–1907

London, University College:
Calendar, session 1906–1907
(*The College.*) 8vo. London, 1906

Lowell Observatory:
Bulletin, No. 25–27.
(*Percival Lowell.*) 4to. 1906–1907

Lowell (Percival):
Mars and its Canals.
(*W. H. Wesley.*) 8vo. New York, 1906

McCaw (George Tyrrell):
*The progress of Geodesy.
(*Author.*) 8vo. Dublin, 1907

Madrid Observatorio Astronómico:
——: Resumen de las observaciones meteorológicas efectuadas en la Peninsula [&c.] 1899–1900.
(*Observatory.*) 8vo. Madrid, 1906
——: Anuario, año 1907.
(*Observatory.*) 8vo. Madrid, 1906

Madrid, Real Academia de Ciencias exactas, físicas y naturales:
——: Anuario, 1907.
(*Academy.*) 16mo. Madrid
——: Memorias, Tomo 24.
(*Academy.*) 4to. Madrid, 1906
——: Revista . . . Tomo 3, No. 6; Tomo 4, No. 1–6; Tomo 5, No. 1–4.
(*Academy.*) 8vo. Madrid, 1906–1907

Manchester Literary and Philosophical Society:
Memoirs and Proceedings, Vol. 50, pt. 3; Vol. 51, pt. 1, 2.
(*Society.*) 8vo. Manchester, 1906–1907

Manchester Municipal School of Technology:
Second Annual Report of the Godlee Observatory, 1906.
(*Observatory.*) 8vo. Manchester, 1907

Manila, Philippine Weather Bureau:
——: Monthly Bulletins. 1905 Nov.–Dec.; 1906 Jan.–Oct.
(*Bureau.*) 4to. Manila, 1906–1907
——: Report of the Director, 1903, pt. 3; 1904, pt. 1, 2.
(*Bureau.*) 4to. Manila, 1905–1906

Mascari (A.):
——: *Statistica delle macchie, facule e protuberanze solari, osservate dal R. Osservatorio, Catania nel . . . . . 1905, 1906.
(*Catania Observatory.*) 4to. Catania, 1905–1906
——: *La periodicita della variazione dello splendore solare dedotto dalle osservazioni delle facule.
(*Catania Observatory.*) 4to. Catania, 1906

Mascart (Jean):
——:* Situation des petites planètes dans la condensation de la nébuleuse de Laplace.
(*Author.*) 8vo. Paris, 1902

Mascart (Jean)—*continued*:
—— : La découverte de l'anneau de Saturne par Huygens.
(*Turnor and Horrox Fund.*) 8vo. Paris, 1907

Mauritius, Royal Alfred Observatory:
—— : Annual Report of the Director for the year 1905.
(*Observatory.*) fol. Mauritius, 1906
—— : Results of magnetical and meteorological observations made . . . . in the year 1904 under the direction of T. F. Claxton.
(*Observatory.*) 4to. London, 1906

Meudon, Observatoire d'Astronomie Physique de Paris:
Annales, ... publiées par J. Janssen.
Tome 3, fasc. 1.
(*Observatory.*) 4to. Paris, 1906

Mexico, Sociedad cientifica "Antonio Alzate"
Memorias y Revista. Tomo 23, No. 5–12.
(*Society.*) 8vo. Mexico, 1906

Missouri University, Laws Observatory:
Bulletin, No. 8–11.
(*Observatory.*) 4to. 1906–1907

Möller (Max):
Orientierung nach dem Schatten: Studien über eine Touristenregel.
(*Author.*) 8vo. Wien, 1905

Moncalieri, Osservatorio Centrale del Real Collegio Carlo Alberto:
Bollettino mensuale (Società Meteorologica Italiana). Serie 3, Vol. 25, No. 5–12; Vol. 26, No. 1, 2.
(*Observatory.*) 4to. Torino, 1906–1907

Moscow, Société Impériale des Naturalistes:
Bulletin, année 1905, No. 1–4; année 1906, No. 1, 2.
(*Society.*) 8vo. Moscou, 1906–1907

Moulton (Forest Ray):
—— : An introduction to Celestial Mechanics.
(*Turnor and Horrox Fund.*)
8vo. New York [Cambridge, Eng.], 1902
—— : An introduction to Astronomy.
(*W. H. Wesley.*) 8vo. New York, 1906

Mount Wilson, California, Solar Observatory:
—— : *Contributions . . . . No. 8–14.
(*Carnegie Institution.*) 8vo. Chicago, 1906–1907
—— : *Report of the Director . . . . for the years 1905, 1906.
(*Carnegie Institution.*) 8vo. Washington, D.C., 1906–1907

Munich, Königlich bayerische Akademie der Wissenschaften:

—— : Abhandlungen der mathematisch-physikalischen Classe. Band 22, Abth. 3.
(*Academy.*) 4to. München, 1906

—— : Sitzungsberichte der mathematisch-physikalischen Classe, 1906, Heft 1–3; 1907, Heft 1.
(*Academy.*) 8vo. München, 1906–1907

Munich, Königliche Sternwarte:

Neue Annalen . . . herausgegeben von H. Seeliger. Supplementheft 1. Meteorologische Beobachtungen.
(*Observatory.*) 4to. München, 1900

Naples, Società Reale (R. Accademia delle Scienze):

Rendiconto dell' Accademia delle scienze fisiche e matematiche: Serie 3: Vol. 12 (Anno 45), fasc. 1–12; Vol. 13, (Anno 46), fasc. 1, 2.
(*Academy.*) 8vo. Napoli, 1906–1907

Natal Observatory:

Report of the Government Astronomer for the years 1905, 1906.
(*Observatory.*) fol. Pietermaritzburg, 1906–1907

Nature. A weekly illustrated journal of science. Vol. 74–76 (No. 1911–1963).
(*Editor.*) 4to. London, 1906–1907

Naturwissenschaftliche Rundschau. Wöchentlicher Bericht über die Fortschritte auf dem Gesammtgebiete der Naturwissenschaften . . . herausgegeben von W. Sklarek. Jahrgang 21, No. 24–52; Jahrgang 22, No. 1–23.
(*Editor.*) 4to. Braunschweig, 1906–1907

Neuchâtel, Observatoire Cantonal:

Rapport du directeur . . . pour l'année 1906, suivi du rapport spécial sur le concours des chronomètres.
(*Observatoire.*) 8vo. La Chaux-de-Fonds, 1907

Newcomb (Simon):

—— : A compendium of Spherical Astronomy, with its applications to the determination and reduction of positions of the fixed stars.
(*Turnor and Horrox Fund.*) 8vo. New York, 1906

—— : Side-lights on Astronomy and kindred fields of popular Science: Essays and Addresses.
(*Turnor and Horrox Fund.*) 8vo. Lond. and New York, 1906

Newton (Sir Isaac):

Opticks, or a treatise of the reflections, refractions, inflections and colours of light. Second edition.
(*T. Colby.*) 8vo. London, 1717

New York, Observatory of Columbia University:
Contributions, No. 1, 2, 24.
(*Observatory.*) 8vo. New York, 1906
No. 24. Anne S. Young. Rutherfurd photographs of the stellar clusters *h* and χ Persei.

Nijland (Albert Antonie):
*J. A. C. Oudemans.
(*Author.*) 8vo. Leipzig, 1907

Norwood (Richard):
—— : Trigonometrie, or the doctrine of triangles . . . whereunto is annexed . . . a treatise of the application thereof in the three principal kinds of sailing (and a triangular canon logarithmical, or a table of artificial sines, tangents, etc.). Eighth edition.
(*T. Colby.*) 2 parts in 1 vol. 4to. London, 1685
—— : The Sea-man's practice: containing a fundamental problem in navigation experimentally verified.
(*T. Colby.*) 4to. London, 1702

Observatory (the). A monthly review of astronomy; edited by T. Lewis and H. P. Hollis. Vol. 29, 30 (No. 372–384).
(*Editors.*) 8vo. London, 1906–1907

Olan (J. W. Th.):
Trisectio Arcus et Anguli.
(*Author.*) obl. fol. Gothenburg, 1906

Olsen (Ole Theodor):
The Fisherman's Nautical Almanac and Tide Tables. 31st year, 1907.
(*Author.*) 8vo. Grimsby, 1906

Oporto, Academia Polytechnica:
Annaes Scientificos. Vol. 1, No. 1–4; Vol. 2, No. 1.
(*Academy.*) 8vo. Coimbra, 1905–1907

Osmons (Henri d'):
Ernest Lebon. (Archives Biographiques contemporaines.)
(*E. Lebon.*) 8vo. Paris

Optical Convention (the):
Proceedings of the Optical Convention, held at the Northampton Institute, London, E.C., May 20th to June 3rd, 1905. No. 1.
(*The Committee.*) 4to. London, 1905

Ottawa, Royal Astronomical Society of Canada:
Journal, Vol. 1, No. 1.
(*Society.*) 8vo. Toronto, 1907

Oudemans (J. A. C.):
*Mutual occultations and eclipses of the satellites of Jupiter in 1908. [2 parts.]
(*A. A. Nijland.*) 8vo. Amsterdam, 1906

Oxford University Observatory:

——: Astrographic Catalogue, 1900·0: Oxford Section, Dec. + 24° to + 32°, from photographs taken and measured . . . . under the direction of H. H. Turner. Vol. 1, 2. Measures of rectangular co-ordinates, etc.
(*Observatory.*) 4to. Edinburgh, 1906

——: Thirty-first and Thirty-second Annual Reports of the Savilian Professor for 1905–6, 1906–7.
(*Observatory.*) 8vo. Oxford, 1906–1907

——: *Miscellaneous papers. No. 117–121.
8vo. London, 1906

Paris, Académie des Sciences:

Comptes rendus hebdomadaires des séances. Tome 142, No. 22—Tome 144, No. 22.
(*Academy.*) 4to. Paris, 1906–1907

Paris, Bureau des Longitudes:

——: Annuaire pour l'an 1907; avec des notices scientifiques.
(*Bureau.*) 16mo. Paris [1906]

——: Connaissance des Temps, ou des mouvements célestes pour le méridien de Paris, à l'usage des astronomes et des navigateurs, 1908.
(*Bureau.*) 8vo. Paris, 1905

——: Connaissance des Temps. Extrait à l'usage des Écoles d'Hydrographie et des marins du commerce, 1907.
(*Bureau.*) 8vo. Paris, 1905

Paris, Dépôt Général de la Marine:

Annales hydrographiques. Série 2. Année 1905.
(*Depôt of Marine.*) 8vo. Paris, 1905

Paris, Observatoire:

——: Annales . . . publiées sous la direction de M. Loewy. Observations, 1902.
(*Observatory.*) 4to. Paris, 1906

——: Carte photographique du Ciel. Zone + 20°, + 22°, + 24° (47 charts).
(*Minister of Public Instruction.*)

——: Rapport annuel sur l'état de l'Observatoire, 1905, par M. Loewy.
(*Observatory.*) 4to. Paris, 1906

Paris, Société Astronomique de France:

Bulletin . . . et revue mensuelle d'astronomie, de météorologie et de physique du globe. Année 20, No. 7—Année 21, No. 6. 8vo. Paris, 1906–1907
(*Society.*)

Paris, Société Mathématique de France:

Bulletin. Tome 34, fasc. 2–4; Tome 35, fasc. 1.
(*Society.*) 8vo. Paris, 1906–1907

Paris, Société Philomathique:
Bulletin. 9me série. Tome 8, No. 2–6; Tome 9, No. 1, 2.
(*Society.*) 8vo. Paris, 1906–1907

Parkhurst (John Adelbert):
Researches in stellar photometry during the years 1894 to 1906, made chiefly at the Yerkes Observatory.
(*Author.*) 4to. Washington, 1906

Pennsylvania, Lehigh University:
Astronomical Papers, Vol. 1, part 1.
(*Observatory.*) 4to. South Bethlehem, Pa., 1907
Results of observations with the Zenith Telescope of the Sayre Astronomical Observatory, 1904–5. J. H. Ogburn.

Perth Observatory, Western Australia:
Meteorological Observations made at the Perth Observatory and other places in Western Australia . . . 1904, 1905, under the direction of W. E. Cooke.
(*Observatory.*) fol. Perth, 1906

Philadelphia, American Philosophical Society:
——: Proceedings, Vol. 45, No. 182–184.
(*Society.*) 8vo. Philadelphia, 1906
——: Transactions. New series. Vol. 21, pt. 3.
(*Society.*) 4to. Philadelphia, 1906
——: The record of the celebration of the two hundredth anniversary of the birth of Benjamin Franklin . . . April 17th to April 20th, A.D. 1906.
(*Society.*) 8vo. Philadephia, 1906

Philadelphia, Franklin Institute:
Journal, year 81, 82. Vol. 161, No. 6—Vol. 163, No. 5.
(*Institute.*) 8vo. Philadelphia, 1906–1907

Philosophical Magazine:
The London, Edinburgh, and Dublin Philosophical Magazine. Series 6, Vol. 12, 13. (No. 67–78.)
(*Turnor and Horrox Fund.*) 8vo. London, 1906–1907

Pickering (Edward Charles):
——:*An international southern telescope.
(*Author.*) 8vo. Lancaster, Pa., 1906
——: *Oration on the aims of an astronomer, delivered . . . . June 28, 1906.
(*Author.*) Cambridge, Mass., 1906

Pickering (William Henry):
——: *Lunar and Hawaiian physical features compared.
(*Author.*) 4to. [Cambridge, Mass., 1906]
——: *The place of origin of the moon—the volcanic problem.
(*Author.*) 8vo. Chicago, 1907

Poincaré (Henri):
Leçons de Mécanique Céleste, professées à la Sorbonne. Tome 1; Tome 2, première partie.
(*Turnor and Horrox Fund.*) 8vo. Paris, 1905–7

Tome 1. Théorie générale des perturbations planétaires.
2, pt. 1. Développement de la fonction perturbatrice.

Pola, Hydrographisches Amt der K. und K. Kriegs-Marine:
Veröffentlichungen, No. 21, 22.
(*Hydrographic Office.*) 4to. Pola, 1906

Popular Astronomy. Edited by W. W. Payne and H. C. Wilson. Vol. 14, 15. (No. 136–146.)
(*Editors.*) 8vo. Northfield, Minn., 1906–1907

Potsdam, Astrophysikalisches Observatorium:
——: Publicationen. Band 15, Stück 1; Band 16, 17.
(*Observatory.*) 4to. Potsdam, 1906–1907

Band 15, Stück 1. H. C. Vogel. Die zwei Doppelrefraktoren des Observatoriums.
,, 16. Müller und Kempf. Photometrische Durchmusterung des nördlichen Himmels, Theil 4.
,, 17. Müller und Kempf. Photometrische Durchmusterung des nördlichen Himmels. General Katalog.

——: Publicationen. Photographische Himmelskarte, Band 4.
(*Observatory.*) 4to. Potsdam, 1907

Potsdam, Centralbureau der Internationalen Erdmessung:
Veröffentlichungen, Neue Folge, No. 13, 14.
(*The Bureau.*) 4to. Berlin, 1906–1907

No. 13. Resultate des internationalen Breitendienstes. Band 2. Th. Albrecht u. B. Wanach.
,, 14. Bericht über die Thätigkeit des Centralbureaus, 1906.

Potsdam, Königl. preussisches Geodätisches Institut:
Veröffentlichung, Neue Folge, No. 26–29, 31, 32.
(*The Institute.*) 4to. and 8vo. Berlin, 1906–1907

No. 26. Jahresbericht des Direktors, 1905-6.
27. Bestimmung der absoluten Grösze der Schwerkraft zu Potsdam. F. Kühnen u. Ph. Furtwängler.
28. Lotabweichungen, Heft 3. A. Börsch.
29. Seismometrische Beobachtungen in Potsdam, 1905. O. Hecker.
31. Astron.-Geodät. Arbeiten, I. Ordnung. Längendifferenz Potsdam-Brocken.
32. Beobachtungen an Horizontalpendeln über die Deformation des Erdkörpers unter dem Einfluss von Sonne u. Mond. O. Hecker.

Poynting (J. H.):
*The pressure of light, being an abstract of the 13th Robert Boyle lecture . . . . 1906.
(*Henry Frowde.*) 8vo. London, 1907

Prague, K.K. Sternwarte:

——: Astronomische Beobachtungen . . . 1900–1904: nebst Zeichnungen und Studien der Mondoberfläche nach photographischen Aufnahmen . . . von L. Weinek.
(*Observatory.*) 4to. Prag, 1907

——: Magnetische und meteorologische Beobachtungen im Jahre 1905. Jahrgang 66 . . . herausgegeben von L. Weinek.
(*Observatory.*) 4to. Prag, 1906

Pulkowa, Observatoire Central Nicolas:

Mittheilungen, Band 1, 2, No. 10–15.
(*Observatory.*) 4to. St-Pétersbourg, 1906–1907

Raffalli (Antoine):

Découverte de la Quadrature du Cercle.
(*Author.*) 8vo. Bastia, 1905

Rey-Pailhade (J. de):

Tables et formules pour l'emploi pratique des instruments décimaux avec la Connaissance des Temps.
(*Turnor and Horrox Fund.*) 8vo. Paris, 1905

Richmond, Surrey, National Physical Laboratory:

*Report of the Observatory department for the year 1905–1906.
(*Laboratory.*) 8vo. Teddington, 1906–1907

Rio de Janeiro, Observatorio:

——: Annuario . . . para o anno de 1906.
(*Observatory.*) 8vo. Rio de Janeiro, 1906

——: Boletim mensal. 1905, No. 7–12; 1906, No. 1–3.
(*Observatory.*) 4to. Rio de Janeiro, 1906

Rome, Reale Accademia dei Lincei:

Atti . . . Anno 303, 304 (1906–1907), Serie quinta. Rendiconti, Classe di scienze fisiche, mathematiche e naturali. Vol. 15, semestre 1, fasc. 11–12, semestre 2, fasc. 1–12; Vol. 16, semestre 1, fasc. 1–10.
(*Academy.*) 4to. Roma, 1906–1907

Rugby School Natural History Society:

Report . . . for the year 1905 (Supplement).
(*The School.*) 8vo. Rugby, 1906

Saint-Blancat (D.):

*Action d'une masse intramercurielle sur la longitude de la lune.
(*Toulouse Observatory.*) 4to. Paris, 1907

St. Petersburg, Académie Impériale des Sciences:

Bulletin, Série 6. 1906, No. 1–9.
(*Academy.*) 4to. St-Pétersbourg, 1907

San Fernando, Instituto y Observatorio de Marina:
—— : Almanáque Náutico para el año 1908.
(*Observatory.*) 4to. San Fernando, 1906
—— : Carta Fotografica del Cielo. Zone – 9°. (39 charts.)
(*French Minister of Public Instruction.*)
—— : Anales . . . . Sección 1. Eclipse Total de Sol del 30 de Agosto de 1905.
(*Observatory.*) 4to. San Fernando, 1906

San Francisco, Astronomical Society of the Pacific:
Publications, Vol. 18, 19 (No. 107–113).
(*Society.*) 8vo. San Francisco, 1906–1907

San Paulo, Sociedade Scientifica:
Revista, No. 2, 3, 4.
(*Society.*) 8vo. São Paulo, 1905–1906

Sanchez (Diodoro):
Biografía de José María Gonzalez Benito.
(*Author.*) 8vo. Bogota, 1907

Saussure (Léopold de):
*L'astronomie chinoise dans l'antiquité.
(*Author.*) 4to. Paris, 1907

Schiaparelli (G. V.):
*Venusbeobachtungen und Berechnungen der Babylonier.
(*Author.*) 4to. Treptow-Berlin, 1906

Science Abstracts. Section A. (Physics). Vol. 10, pt. 1–5.
(*Institution of Electrical Engineers.*) 8vo. London, 1907

See (T. J. J.):
—— : *Researches on the rigidity of the heavenly bodies.
(*Author.*) 4to. Kiel, 1906
—— : *The cause of earthquakes, mountain formation, and kindred phenomena connected with the physics of the earth.
(*Author.*) 8vo. Philadelphia, 1907

Seeliger (Hugo):
——: *Das Zodiakallicht und die empirischen Glieder in der Bewegung der innern Planeten.
(*Author.*) 8vo. München, 1906
—— : *Über die empirischen Glieder in der Theorie der Bewegung der Planeten Merkur, Venus, Erde und Mars.
(*Author.*) 8vo. Leipzig, 1906

Sirius. Zeitschrift für populäre Astronomie; Redakteur H. J. Klein. Band 39, Heft 6–12; Band 40, Heft 1–5.
(*Editor.*) 8vo. Leipzig, 1906–1907

[Smith (George Frederick Herbert)]:
* Obituary Notice of Robert Philips Greg, 1826–1906.
(*Author.*) 8vo. London, 1907

Snyder (Carl):
The World Machine: the first phase—the cosmic mechanism.
(*W. H. Wesley.*) 8vo. London, 1907

Solar Research (International Union for Co-operation in):
Transactions. Vol. 1 (first and second Conferences).
(*Turnor and Horrox Fund.*) 8vo. Manchester, 1906

Souchon (Abel):
Notice historique sur le mouvement de l'Apogée lunaire.
(*Author.*) 8vo. Tours, 1903.

South Kensington, Solar Physics Observatory:
—— : Report made to the Solar Physics Committee by Sir Norman Lockyer, 1906.
(*Observatory.*) 8vo. London, 1906
—— : Tables of wave-lengths of enhanced lines: compiled from investigations made . . . under the direction of Sir Norman Lockyer.
(*Observatory.*) 4to. London, 1906
—— : Spectroscopic comparison of metals present in certain terrestrial and celestial light-sources (with special reference to Vanadium and Titanium).
(*Observatory.*) 4to. London, 1907

Southport, Fernley Observatory:
Report and results of [meteorological] observations for the years 1905–1906, by J. Baxendell.
(*Author.*) 4to. Southport, 1906–1907

Spitzbergen:
Missions scientifiques pour la mesure d'un arc de Méridien au Spitzberg, entreprises en 1899–1901, sous les auspices des Gouvernements Russe de Suédois. Mission Russe. Tome 1, Geodésie, Sections 3–5.
(*Pulkowa Observatory.*) 4to. St-Pétersbourg, 1905

Stockholm, Kongliga Svenska Vetenskaps Akademie:
—— : Arkiv för mathematik, astronomi och fysik. Band 2, Heft 3, 4; Band 3, Heft 1.
(*Academy.*) 8vo. Upsala and Stockholm, 1905–1906
—— : Årsbok för år 1906.
(*Academy.*) 8vo. Stockholm, 1906

Stokes (Sir George Gabriel):
Memoir and Scientific Correspondence of the late Sir George Gabriel Stokes, Bart. . . . Selected and arranged by Joseph Larmor.
(*Turnor and Horrox Fund.*) 2 vols. 8vo. Cambridge, 1907

Stonyhurst College Observatory:
Results of meteorological and magnetical observations, with report and notes of the director, Rev. W. Sidgreaves, 1906
(*Observatory.*) 8vo. Clitheroe, 1907

Stroobant (Paul):
*La constitution de l'anneau des petites planètes.
(*Author.*) 4to. Bruxelles, 1907

Sun, total Eclipse of, 1905:

*Rapporto della Commissione Italiana per l'Eclipse totale di Sole del 30 Agosto 1905, osservata ad Alcalà de Chivert (Spagna).
(*Catania Observatory.*) 4to. Catania, 1906

Tacubaya, Observatorio Astronómico Nacional:

Anuario . . . para el año de 1907. F. Valle. Año 27.
(*Observatory.*) 8vo. México, 1906

Taylor (Harold Dennis):

A system of Applied Optics; being a complete system of formulæ of the second order, and the foundation of a complete system of the third order; with examples of their practical application.
(*Author.*) 4to. London, 1906

Toronto, Royal Astronomical Society of Canada:

Journal, Vol. 1, No. 1, 2.
(*Society.*) 8vo. Toronto, 1907

Tortosa, Observatoire de l'Ebre:

Mémoires, No. 1.
(*Observatory.*) 4to. Barcelona, 1906
Notice sur l'observatoire, et sur l'éclipse de 30 août 1905.

Toulouse, Académie des Sciences, Inscriptions et Belles-lettres:

Mémoires . . . . 10me série. Tome 5.
(*Academy.*) 8vo. Toulouse, 1905

Toulouse, Commission Météorologique de la Haute-Garonne:

Bulletin. Tome 1, fasc. 4. 1904.
(*Toulouse Observatory.*) 4to. Toulouse, 1905

Toulouse, Observatoire Astronomique, Magnétique et météorologique:

—— : Catalogue photographique du Ciel (Observatoire de Toulouse). Coordonnées rectilignes, Tome 7, fasc. 3.
(*French Minister of Public Instruction.*) 4to. Paris, 1906
Another copy presented by M. H. Bourget.

—— : Carte photographique du Ciel: Zones $+5^\circ$, $+7^\circ$, $+9^\circ$. (39 charts.)
(*French Minister of Public Instruction.*)

Trépied (Charles):

Tables et Cartes d'occultations. Théorie et applications. [Observatoire d'Alger.]
(*Observatory.*) 4to. Paris, 1905

Truro, Royal Institution of Cornwall:

Journal, Vol. 16, pt. 3, Vol. 17, pt. 1. (1906, 1907.)
(*Institution.*) 8vo. Truro, 1906–1907

Turin, Realè Accademia delle Scienze:
—— : Atti, Vol. 41, No. 7–15; Vol. 42, No. 1–6.
(*Academy.*) 8vo. Torino, 1906–1907
—— : Memorie, Serie seconda. Tomo 56.
(*Academy.*) 4to. Torino, 1906

Turin, Reale Osservatorio:
Annuario astronomico, pel 1905–1907.
(*Observatory.*) 8vo. Torino, 1905–1907

Turin, Società Astronomica Italiana:
Revista di Astronomia e scienze affini. Anno 1, No. 1–4.
(*Society.*) 8vo. Torino, 1907

Uccle, Observatoire Royal de Belgique:
—— : Annales . . . Nouvelle série; Annales Astronomiques. Tome 9, fasc. 2, 3.
(*Observatory.*) 4to. Bruxelles, 1906–1907
—— : Annales . . . Nouvelle série: Physique du Globe. Tome 3, fasc. 1, 2. Travaux publiés par les soins de G. Lecointe.
(*Observatory.*) 4to. Bruxelles, 1905–1906
—— : Annuaire astronomique, 1907.
Annuaire météorologique, 1906.
(*Observatory.*) 16mo. Bruxelles, 1906–1907

United States Coast and Geodetic Survey:
Report of the Superintendent . . . showing the progress of the work during the year 1905–6.
(*Survey Office.*) 4to. Washington, 1906

Vienna, Kaiserliche Akademie der Wissenschaften:
—— : Denkschriften . . . Mathematisch-naturwissenschaftliche Classe. Band 78.
(*Academy.*) 4to. Wien, 1906
—— : Sitzungsberichte . . . Mathematisch-naturwissenschaftliche Classe. Abtheilung II.a., Mathematik, Astronomie, Physik, Meteorologie, Mechanik. Band 114, Heft 1–10.
(*Academy.*) 8vo. Wien, 1905

Vienna, K. K. Gradmessungs-Bureau:
—— : Astronomische Arbeiten . . . ausgeführt unter der Leitung von Th. von Oppolzer. Nach dessen Tode herausgegeben von E. Weiss und R. Schram. Band 14. Pendelbeobachtungen.
(*Bureau.*) 4to. Wien, 1907

Vienna, K. und K. Militär-geographisches Institut:
—— : Astronomische-geodätische Arbeiten. Band 21.
(*Institute.*) 4to. Wien, 19
Astronomische Arbeiten, 9: Polhöhen u. Azimuth-Messungen.

Vienna, K. und K. Militär-geographisches Institut—*contd.*:
——: Die Ergebnisse der Triangulierungen . . . Band 4.
(*Institute.*) 8vo. Wien, 1906

Vienna, Österreichische Kommission für die Internationale Erdmessung:
Verhandlungen: Protokolle über die am 29 Dezember 1904 und 29 Dezember 1905 abgehaltene Sitzungen.
(*Commission.*) 8vo. Wien, 1905

Vives y Vich (Pedro):
Avance de los resultados obtenidos en las observaciones del eclipse total de Sol de 30 de Agosto de 1905.
(*Author.*) 4to. Madrid, 1906

Wallace (Robert James):
——:*Color-filters for astronomical photography.
(*Author.*) 8vo. Chicago, 1906
——: *Studies in sensitometry. I. The daylight sensitometry of photographic plates, and a suggested standard dispersion-piece.
(*Author.*) 8vo. Chicago, 1907

Warsaw, Observatoire de l'Université Impériale:
——: Observations faites au cercle méridien . . . 3me partie, fasc. 1, 2.
(*Observatory.*) 4to. Varsovie, 1902–1903
——: Sterncatalog . . . . Zone – 2° bis – 7°.
(*Observatory.*) 4to. Warschaw, 1904

Washburn Observatory of the University of Wisconsin:
Publications. Vol. 10, pt. 3.
(*Observatory.*) 4to. Madison, Wis., 1907
G. C. Comstock. Observations of Double Stars, 1897–1906.

Washington, Bureau of Standards:
Bulletin . . . . S. W. Stratton, Director. Vol. 1.
(*The Bureau.*) 8vo. Washington, 1904–1905

Washington, Navy Department:
The American Ephemeris and Nautical Almanac, 1909.
(*American Ephemeris Office.*) 8vo. Washington, 1906

Washington, Philosophical Society:
Bulletin. Vol. 14, pp. 339–450: Vol. 15, pp. 1–26.
(*Society.*) 8vo. Washington, 1906–1907

Washington, Smithsonian Institution:
——: Annual Report of the Board of Regents, ... 1905: Report of the U.S. National Museum, 1905–1906.
(*Institution.*) 8vo. Washington, 1906
——: Smithsonian Contributions to Knowledge. No. 1694.
(*Institution.*) 4to. Washington, 1907

Washington, Smithsonian Institution—*continued*:
——: Smithsonian Miscellaneous Collections. No. 1652, 1656 (forming part of Vol. 49).
(*Institution.*) 8vo. Washington, 1906–1907

Washington, United States Naval Observatory:
——: Report of the Superintendent . . . for the year ending June 30, 1906.
(*Observatory.*) 8vo. Washington, 1906
——: Publications. Second Series. Vol. 4, pt. 1–3.
(*Observatory.*) 4to. Washington, 1906

Yale University, Astronomical Observatory:
Transactions, Vol. 2, pt. 1.
(*Observatory.*) 4to. New Haven, 1906
F. L. Chase [etc.]. Parallax investigations on 163 Stars.

Yerkes Observatory of the University of Chicago:
Publications, Vol. 3, pt. 2.
(*Observatory.*) 4to. Chicago, 1907
G. E. Hale and N. A. Kent. Spectrum of high potential discharge, etc.

Zeitschrift für Instrumentenkunde. Organ für Mittheilungen aus dem gesammten Gebiete der wissenschaftlichen Technik. Jahrgang 26, Heft 6–12; Jahrg. 27, Heft 1–5.
(*Turnor and Horrox Fund.*) 4to. Berlin, 1906–1907

Zenger (Carl Venceslas):
——: *La théorie électrodynamique du monde et le radium.
(*Author.*) 8vo. Paris, 1905
——: *La théorie électrodynamique du monde et les éruptions volcaniques et grands sismes.
(*Author.*) 8vo. Paris, 1905
——: *La période Luni-Solaire et le temps qu'il fera pendant l'éclipse du 30 août 1905.
(*Author.*) 8vo. Paris, 1905

Zi-ka-wei Observatoire Astronomique de Zô Sè:
Annales, année 1, fasc. 2 [texte et atlas].
(*Observatory.*) 4to. Chang-Hai, 1907

Zürich, Naturforschende Gesellschaft:
Vierteljahrsschrift, Jahrgang 51, Heft 1–4.
(*Society.*) 8vo. Zürich, 1906–1907

Zürich, Schweizerische meteorologische Centralanstalt:
Annalen, 1904, 1905. Jahrgang 41, 42.
(*Institute.*) 4to. Zürich, 1906–1907

PHOTOGRAPHS PRESENTED TO THE SOCIETY.

Baume Pluvinal (Comte de la)—Photographs of the total solar eclipse, 1905 August 30, taken at Alcala de Chisvert, Spain (2 transparencies and lantern slide).

Mitchell (S. A.)—Flash spectrum, photographed at Daroca, Spain, 1905 August 30 (2 lantern slides).

Royal Observatory, Greenwich.—Photograph of the total solar eclipse, 1905 August 30, taken at Sfax, Tunis (print), and enlarged photographs of sun-spots, taken at Greenwich 1906 July–August (6 transparencies).

Sidgreaves (Rev. W.)—Photographs of spectrum of Mira Ceti (lantern slide and print).

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